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ABSTRACT

Twenty papers on multi-cultural aerospace education are presented and cover a wide range of topics, all dealing with some aspect of teaching aerospace education with or without applications to the teaching of minority students. Aerospace education as a motivating force in learning is the topic of two papers. Minorities in aerospace education, as a general topic, is covered in nine papers: four papers deal specifically with women in aerospace education. One paper reviews a course taught by its author in which American values and the history of aviation are related. An explanation of the LEARNBALL format (a student-team approach to learning) for classroom organization is another topic. Implications of space education for the future are made in two other papers.
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INTRODUCTION

The role of the museum in today's society is a complex one, embodying elements of ancient tradition, modern educational methods, the constraints of historical accuracy, the need for wide-spread and useful communication, sometimes the patronage of monied interests, and always the support of the visiting public. Museums were once the domain of the very privileged, those who were wealthy enough to acquire collections and those who were sufficiently socially acceptable to be considered their peer group.

In his book The Sacred Grove, the Secretary of the Smithsonian Institution, S. Dillon Ripley, quotes a notice inserted in the London newspapers of September 13, 1773 by Sir Ashton Lever, proprietor of one of the earliest public museums. Sir Ashton Lever said:

"This is to inform the publick that being tired out with the insolence of the common people, who I have hitherto indulged with a sight of my museum (at Alkington), I am now come to the resolution of refusing admittance to the lower class except they come provided with a ticket from some gentleman or lady of my acquaintance. And I hereby authorize every friend of mine to give a ticket to any orderly man to bring in eleven persons, besides himself whose behaviour he must be answerable for, according to the directions he will receive before they are admitted. They will not be admitted during the time of gentlemen and ladies being in the museum. If it happens to be inconvenient when they bring their ticket, they must submit to go back and come some other day, admittance in the morning only from eight o'clock till twelve."

What an affront to our modern sensibilities! What a shock to realize that only the tiniest upper layer of 18th century English society had the privilege of not having to grovel in order to glean for themselves a bit of the educational opportunities afforded by a museum.

Things are certainly better today, but so much remains to be done. The museum community is learning that it must offer its intellectual sustenance to a wide range of society. Specifically, today's problem is that of

ensuring that the benefits of museum education are available and relevant to all, encompassing groups as diverse as young school children, middle-aged scholars, men, women, whites, blacks, native Americans, the handicapped, recent immigrants, and old-line Americans. Even if the museum is available and relevant, the problem of minority attendance is only partially under the museum's control. An individual may be starving for education and intellectual enrichment; however, if that same individual is also starving for food, a museum visit might not top his or her priority list.

This Conference on Multi-Cultural Aerospace Education is a step in the right direction; however, it is only a step. There must be other steps by this organization and others. There must be a follow-up to transform the right words into the right activities. We must keep the goals of relevance and accessibility before us as we progress toward the improvement of our organizations and ourselves. Hopefully, this Conference and its results will advance us toward our ideals.

Melvin B. Zisfein
Deputy Director
National Air and Space Museum
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KEYNOTE: "COMMUNICATING OUR AEROSPACE LEGACY"

Nichelle Nichols
President
Women in Motion, Inc.
Los Angeles, California

Thank you Dr. Joels, Dr. Hinners, Mel Zisfein and staff, and good afternoon ladies and gentlemen. Welcome to the Smithsonian Institution National Air & Space Museum's First Annual Conference on Multi-Cultural Aerospace Education. This is a special occasion for me and I feel most honored to have been chosen your keynote speaker. As such, I hope that my remarks set the tone of the unique and important information and dialogue that will be imparted and shared these next few days.

Not being a professional educator like yourselves, I have particular interest in the aerospace projects and programs you have been developing for your students and the response and results derived. As for myself, I am a communicator by profession. My own contribution has been in my recognition of the importance of space in our lives and future, and my dedication to communicating the immense value of space research and the great potential of exploring, industrializing, colonizing and utilizing the yet unknown secrets of space; for I believe uncovering the secret of our universe enriches and enables humankind in ways we've yet to dream.

It's been especially fortunate for me that Gene Roddenberry, the creator of Star Trek, the T.V. series, whose philosophy projects a future in space of great promise and dignity, chose me to portray Uhura, the Chief Communications Officer aboard the Star Ship Enterprise: its crew comprised of men and women of every color, race and faith on earth, as well as intelligent life forms from other planets in and outside our galaxy. This might have been just another benign science fiction entertainment, perhaps one of the better T.V. fare, if not for the Star Trek directive of space exploration with non-interference with other cultures, with respect for infinite diversity in all its infinite combinations. This then, the noblest of purposes that we as Earthlings could envision, became the dream.

This dream caught the imagination and hope of millions of people and Star Trek became a phenomenon of our time and a positive blue print for what could be if we but recognize the possibility of its reality, 300 years from now, with a strong responsibility to our space program today. That means for one thing a strong aerospace education for young people and aerospace awareness for the general public.

When NASA asked me to assist them in their recruitment of women and minorities as astronauts for the space shuttle, I felt touched by destiny and proud to help. It was an enriching experience.

As a member of the Board of Directors of the National Space Institute, I've learned much much more about the importance of communicating our

aerospace heritage. However, the only way I could give my whole being to space and not neglect my own personal career was to combine them.

I formed my own company, Women in Motion, Inc. (or WIMINC) a consulting firm on aerospace education and awareness.

I immediately began developing and producing aerospace projects and programs for youth, symposia, and seminars and Space Days, also lecturing to career women on their place in space which offered career options.

In interviews on T.V. and radio, and appearances for newspapers and magazines, they seem to be fascinated that a fictional astronaut of the future is so involved in promoting the real space program today.

I've co-written a musical about the first woman in space and her forward look of colonization. It's called Ancestry because we're all ancestors of all the future generations.

Currently, my company, Women in Motion, Inc. is producing an orientation film I've written for the Smithsonian Air & Space Museum, for school students.

In this way, I get to sing, dance, write, speak or act in the very productions we produce and still dramatize and promote real space. You see, I'm getting to have my space cake and eat it too.

That is why I feel this Conference on Aerospace Education is so important. It is vital that the many innovative means you've created for your students be shared with one another and documented for other educators across the country.

And that is why I feel so honored to be here with you and to learn from you and pledge to you my continued dedication in communicating our great Aerospace Heritage.

Thank you.

AN INTERDISCIPLINARY APPROACH TO MULTICULTURAL EDUCATION

Dorine S. Class

Jet travel and electronic communications continue to shrink our planet within our own generation. In this shrinking world, attitudes and beliefs become important as they inhibit or promote solution of problems which are becoming worldwide; inequitable distribution of wealth and natural resources, the energy shortage, atmospheric pollution, control of the development of nuclear weapons, and the protection of human health and welfare, among others. Since attitudes and beliefs are learned through experience, or the lack of it, public schools and other institutions should provide experiences, from early childhood throughout life, which would further acceptance of cultural diversity and social change. This becomes a societal curriculum, in contrast to the limited curriculum which educational institutions can provide. Societal curricula have always been with us, their ends being reached through legislation or the courts, for the most part, and occasionally through revolution.

If we accept the concept of multicultural education becoming a societal curriculum to develop a system of beliefs and behaviors which respects and advances the value and potentiality of all people, how do we deal with it?

First, multicultural education should be designed for everyone. Courses of study or exhibits planned to advance the status of women and minorities in the American society often raise their abilities and expectations without providing entry into society.

Second, multicultural education should be designed as planned change, providing for an interdisciplinary approach which permeates all institutions of learning. Schools alone cannot meet the goal of a multicultural society. The contradiction between the goals of education for a racially and culturally diverse society and continuing socialization in only middle class ethnocentric norms causes instruction to fail since the instruction is for living in a society which does not yet exist.¹ Outlined below is a tentative program that various public institutions might consider in a societal curriculum to develop an interdisciplinary approach to multicultural education.

Definition and Goals of Multicultural Education

Planning for change begins with a consensus as to understanding and purpose. The definition and goals of multicultural education set out below are proposed as a starting point to reach such consensus.

Multicultural education is an interdisciplinary teaching/learning process designed to ensure the development of cultural awareness,

¹ Carl A. Grant, "Classroom Socialization: The Other Side of a Two-Way Street," Educational Leadership, Vol. 36, No. 7, April 1979, p. 471.

recognition of human dignity, and respect for each person's origins and rights. It is a process which promotes understanding and a respect for similarities and differences within one's own culture group and within other culture groups through intergroup and human relations education.²

The goals of multicultural education would be to develop, in each person:³

a positive sense of identity and self-esteem;

the ability to relate to people in a multicultural society and recognize the worth and contributions of people of all cultures;

the basic skills of mathematics;

the ability to reason, to make decisions, and to solve problems;

attitudes and habits conducive to maintaining mental and physical health;

a foundation for personal appreciation, understanding, judgement, and performance of the creative arts;

a knowledge of the past and of the present and ability to live with rapid change;

skill in the use of complex motor patterns;

an awareness of the relationship between self and the economic system;

an awareness of the nature of the universe;

positive personal and social values.

The planned program should provide training for all participants, leaders as well as learners, in the knowledges and skills which underlie the curriculum. Measurable and attainable outcomes should be proposed. Examples might be, at the beginning of such a program, that

1) education

2) occupations, and

² Multicultural Education Coordinating Committee, Los Angeles Unified School District, Area 2 Instructional Memorandum 38, March 1979.

³ Los Angeles Unified School District, Elementary School Curriculum, Guidelines for Instruction, Publication No. EC-436, 1977 revision, p. 61.1.

3) leadership roles

be available to any qualified person, regardless of race, culture, or sex. That they are not now is more a matter of society's customs and traditions than it is a matter of lack of able women and minorities.

Background to Development of the Interdisciplinary Approach

A variety of approaches to multicultural education have been used in California and the Los Angeles Unified School District over the past decade and a half, most of them developed by teachers, individually or in committee. Since multicultural education was not a recognized part of the national educational curriculum until recently, it began in a do-it-yourself fashion with those educators who saw a need.

The District's emphasis was and, of necessity, continues to be on instruction in the basic skills of oral and written language, reading, and mathematics. Teachers lacked knowledge of minority cultures and of interpersonal communication techniques. Little information about this was then available for the researcher. The District, accustomed to the usual public school curriculum, had limited relationships with community institutions and is only now beginning to enter into cooperative partnerships with museums, universities, and other community resources.

Events forced multicultural education upon the District. Multicultural education was first mandated by the Federal Government (Elementary and Secondary Education Act, 1965) and the State of California (Early Childhood Education Act, 1972) but was limited to the relatively few schools receiving funds for those programs. It has been only since 1976 that the State and District began to implement a policy of multicultural education in all schools. But student and staff integration and increased minority participation over the past ten years forced the need for multicultural education prior to then. However, the size and diversity of the District, and its policy of decentralizing decision-making on specific instructional programs to the local school, militate against a single instructional program. There are more than 561,000 students, Kindergarten through grade 12 in 534 schools, in a geographical area which is 43 miles long and 29 miles wide. Thus the factors described above led to a variety of approaches.

Ethnic Studies. The earliest approach was designed to fill a gap left by the lack of materials and textbooks recognizing the contributions of ethnic minorities to American history. While this approach is still used by many teachers, because it takes time and money to change a school's curriculum, its disadvantages are generally recognized. Ethnic studies may have improved minority children's self-esteem, but it failed to build intergroup understanding. Materials, mostly teacher-developed, were uneven in quality, coverage, and distribution, and, in some cases, were believed to foster stereotypes where none may have existed.

Bicultural Education. Beginning as an adjunct to bilingual instruction, bicultural education's purpose was to maintain and expand students' knowledge and appreciation of their own diverse culture while attaining knowledge and skills required to succeed in the mainstream of American society. Ethnic

studies with a bicultural approach made multicultural education seem more purposeful to teachers.

As with the ethnic approach, materials tended to be teacher-developed, although more often by committees whose members were drawn from several schools. Attempts to locate teacher-experts in the cultures under study were made, but there continued to be few published materials useful for research or instruction. Materials thus developed instilled knowledge about specific ethnic groups, rather than intergroup skills and understandings, and their distribution was still very limited.

Cross-cultural Approach. In the mid-1970's, the California State Department of Education, recognizing that nearly one-third of the State's students in public schools were members of racial and ethnic minority groups and that more than one in five of all California students attended schools of predominantly minority composition, mandated multicultural education in any District where its racial and ethnic survey revealed a multicultural population. Relatively specific goals were set in every school for students, staff and parents.⁴

- Goal I. Self-concept and attitudes towards school and learning are equally positive in students of all ethnic groups.
- Goal II. Academic achievement of students from all ethnic groups matches or exceeds accepted norms.
- Goal III. Multiethnic, multicultural activities are developed in which curriculum materials, teacher attitudes and teaching procedures provide each child with an opportunity to understand and to develop pride in his own ethnic heritage and to understand, respect and accept the ethnic heritage of other groups in the classroom and in society.
- Goal IV. Educators of all ethnic groups are integrated throughout the staff of the school so that the opportunity structure is equally open to all. This implies that educators from all ethnic groups are recruited and come to have status and roles at all levels.

... in schools with a diverse racial and ethnic population...

- Goal V. Students of all ethnic groups are integrated into the social system of the school so that students of all ethnic groups hold comparable status and play comparable roles. This means that children of all ethnic groups come to perceive each other as peers and friends, and that the distribution of valued statuses and roles in the school is similar for all groups.

⁴ California State Department of Education, Bureau of Intergroup Relations, "A Statement on Needs and Goals of Multicultural Education," undated.

Goal VI. Parents of children of all ethnic groups are integrated into the life of the school so that they hold comparable status and play comparable roles in school-related organizations and activities.

At that time, multicultural education was defined by the State Department of Education as:⁵

a comprehensive, interdisciplinary educational process which has as its primary goal the development of human dignity and respect for all peoples. Within this definition lie the concepts embraced by cultural pluralism, bilingual education, cross cultural education, ethnic and cultural studies, and intergroup and human relations. Understanding differences, and more importantly, accepting them becomes an essential factor in the overall program.

To accomplish this understanding and acceptance, as opposed to simple toleration, it becomes essential that the multicultural education program provide an opportunity for children to develop an awareness of the differences within and between peoples, acquire a knowledge of why they exist, and the skills to cope and effectively relate to the demands of living in a pluralistic society.

Concurrently, the District had established a number of Ethnic Centers (now called Multicultural Centers) to serve the schools, and had set up four Education Commissions (American Indian, Asian, Black, and Mexican-American). These groups began to exchange materials which had been developed, including materials from other school districts, and they were the impetus behind the development and location of new instructional materials. Textbooks and other commercial materials became available.

The crosscultural approach, comparing two or more cultures, is widely used in social studies textbooks. In actual practice at schools, however, it tends to follow a "calendar" format--celebrating special holidays and events of the month--or develop "cultural" units, focusing, each listing a month to six weeks on one of several units, each emphasizing a single culture. The result is a patchwork of ethnic studies, again stressing knowledge about cultures rather than intergroup understandings, skills and attitudes.

The Interdisciplinary Approach. In 1975, the State Legislature required that in order to retain their teaching credentials, all educators must complete the equivalent of a minimum of four college credits in multicultural education, with the course outline for these classes to be approved by the State Department of Education.

Then, in 1978, the State Board of Education established its policy on multicultural education, to the effect that "an over-riding educational philosophy be adopted (by each school district) that is based on the common humanity underlying all groups and that respects the cultural and individual differences of all people which reflect that common humanity, regardless of

⁵ Ibid.

their racial, ethnic, cultural or religious backgrounds, or physical differences." The policy states that "multicultural education is an interdisciplinary process rather than a single program or a series of activities," and that, included in this process are the concepts embraced by cultural pluralism, ethnic and intercultural studies, and intergroup and human relations.⁶

Thus the interdisciplinary approach has developed slowly over time, and has not been implemented.

Staff Development

The State left to each school district the determination of appropriate student and staff outcomes, with such outcomes attending to knowledge, attitudes, and skills that students and staff are expected to acquire.

Los Angeles' staff development process describes five "stages of readiness":⁷

1. Awareness - the faculty discusses cultural differences, key concepts, associated terms and practices.
2. Planning - the faculty plans and develops learning activities, instructional programs and instructional strategies.
3. Implementation vis-a-vis the additive approach - the faculty teaches "ethnic units" or "lessons" or "special events" which enrich or are substituted for the regular curriculum.
4. Evaluation of impact - use of pre/post measures to determine expectations of behavioral change.
5. Total infusion/interdisciplinary orientation -- all instruction becomes multicultural, most learning activities are not single-subject oriented, and new decision-making and management systems are in place.

As the writer sees it, most teachers and schools have not and will not likely go beyond "stage three" unless they address student and staff outcomes. In "stage two," schools' staffs should determine desired measurable behavioral changes to be expected of themselves and the students.

Student Outcomes

Too often, educational skills are limited to the basic three R's, knowledge is limited to the historic past, and attitudes are limited to those behaviors which enable students to get along with others and work in

⁶ State of California, Department of Education, "State Board of Education Policy on Multicultural Education," memorandum dated April 4, 1978.

⁷ Los Angeles Unified School District, "Multicultural Staff Development: Five Stages of Readiness," undated.

large groups, self-control and discipline. These are highly visible, easily observed skills, knowledges, and attitudes. But the skills, attitudes and knowledge students are expected to gain from multicultural education are usually unstructured, if not amorphous, unless they can be related to the immediate task, a specific "piece of learning," observable objective, or unit of knowledge. This is the point where the school and societal curricula begin to split, with the school's purpose being to prepare the child to succeed at school rather than in an unknown future.

If we really want to change the world, we should begin with what we are able to do in our neighborhood and work communities. Consequently, student outcomes become important as they reflect the expectations of and objectives we have for children and ourselves.

A Matrix of Multicultural Skills

In Los Angeles' Area 2, a matrix of multicultural skills has been developed in an attempt to give structure to skills, knowledge and attitudes an interdisciplinary approach might expect as outcomes in grades Kindergarten through 12. The framework of the matrix is outlined below. Currently, the matrix contains 56 measurable performance objectives for students.

The matrix has three strands: self-identity and awareness of others, cultural awareness and appreciation, and human relations. Each strand is being developed at three levels: primary grades, intermediate, and secondary. The following items constitute the horizontal of the matrix:

STRAND I: SELF-IDENTITY AND AWARENESS OF OTHERS

Goal: The learner will advance in self-knowledge and esteem and knowledge and esteem of others.

A. Personal Self-Image

Major Objective: The learner will recognize herself/himself as a member of the human family, possessing a unique combination of physical traits, abilities, emotions, needs, and wishes.

B. Ethnic Self-Image

Major Objective: The learner will have knowledge of and a positive feeling about his/her own heritage.

C. Awareness of Others

Major Objective: The learner will be aware of the classified racial groups and will recognize racial, ethnic, and cultural differences as characteristics to be valued.

STRAND II: CULTURAL AWARENESS AND APPRECIATION

Goal: The learner will acquire awareness, understanding, knowledge, and acceptance of various cultural groups.

D. Ethnic and Cultural Groups in Our Society

Major Objective: The learner will become aware that there are identified ethnic groups and will appreciate their cultural diversity.

E. Group Characteristics

Major Objective: The learner will develop knowledge of the characteristics, contributions, and history of the ethnic groups studied, including special days and events, literature, customs, achievements, values, art, music, language, foods, traditional dress, games, etc.

F. Respect for and Appreciation of the Contributions of Various Cultures

Major Objective: The learner will recognize that the nature and quality of American life is the result of many contributions and achievements, by individuals from his/her own and other cultures, today and in the past.

STRAND III: HUMAN RELATIONS

Goal: The learner will advance in interpersonal relations and develop skills in problem-solving.

G. Interpersonal Relations and Group Understandings

Major Objective: The learner will recognize that each individual has emotions, feelings, attitudes, and beliefs and may express them in different ways at different times.

H. Social Problems and Conflicts

Major Objective: The learner will identify or describe social problems and conflicts in our society, today and in the past, and will develop techniques to resolve conflicts, solve problems, and make decisions affecting his/her own life.

An interdisciplinary approach to multicultural education assumes education of the whole society, rather than special groups such as school children, women, and minorities. Optimally, it would involve all institutions which educate society: museums, universities, the media, government, business, as well as the schools. It would be a holistic approach to the development of individual and collective knowledge, skills, and attitudes, not a separate unit of study or exhibit.

The primary purpose should be the development of human potentiality, human dignity, and respect for all people. This great adventure begins with the individual, and each of us must display the open attitudes, cooperation, and respect for each other that we expect our children to learn, because our behaviors teach and our behaviors set the real societal curriculum. To change society, we must begin by changing ourselves to the current realities.

WOMEN: STUDY IN ENGINEERING PROGRAM;
UNIVERSITY OF MARYLAND, COLLEGE PARK

By:

William A. Wockenfuss, Instructor, Mechanical Engineering
and
Marilyn R. Berman, Counselor
College of Engineering
University of Maryland

Despite new-found freedom in many directions, too few women are upgrading their career goals and going after the better-paying jobs in business, industry and the professions. About ten percent of the student body of Engineering schools are women. The projected need for engineers through the next decade will far exceed the number of students graduating from engineering schools. The problem is not, therefore, to create jobs for women in industry and the professions, but rather to create women engineers to fill the available openings.

The absence of women in science and engineering is a direct result of the socialization of what is perceived as the role of women in the work force. This process deters girls from seeking training in the foundations necessary for technical careers.

Women have in the past not devoted their potentials and efforts to solving technologically oriented problems. In order for our culture to thrive, all of our resources (human and material) must be utilized efficiently. We cannot afford to waste half of the human potential we have. A special effort needs to be made to attract women and encourage women to devote their energies to the new technologies.

Conditioning of sex roles begins at birth. The "pink for girls -- blue for boys" syndrome is only the beginning symbol of the differentiated way that girls and boys will be treated throughout their childhood. Girls get dolls, doll houses and miniatures of all the equipment that Mother uses; boys are given trucks, guns and miniatures of all the equipment Father uses. By the age of 5, children have already internalized society's expectations of them -- little girls want to grow up to be mothers and set career goals later, so as not to conflict with that goal; little boys want to grow up to be doctors, lawyers, engineers, without conflicts over parenthood.

The channeling of girls into specific vocations seen as acceptable for women (such as secretary, teacher, nurse) is reinforced by the educational system. The institutional reinforcement, as well as the women's own reluctance to set their sights with a broad enough scope, perpetuates the limiting of certain career choices. Females themselves view certain careers as more acceptable than others. In addition to the obvious and overt social rejection that a competitively achieving girl may experience, there is also an internal anxiety, a fear about one's femininity. So, in effect, a fear of success becomes an important motive for women.¹

¹ Matena S. Horner, "Fail: Bright Women" Psychology Today (November 1969).

American society has prided itself on its concern for the fullest development of each individual's creative potential. As educators, we have recently become sensitive to the handicaps imposed on members of our society on the basis of their race and class. We must also address ourselves to the handicaps imposed on women because of their sex.

One of the most important changes in the lives of women in our technological society is the number who are employed. Predictions are that 9 out of 10 of today's girls will be part of the work force at some time in their lives. Even though most girls will marry, and a majority will have children, they will work for a significant portion of their lives. Women, like men, work because they need the money to support themselves and their families. There are thirty million women workers who are a part of the work force. A substantial portion of the human resources of our nation (women) must be trained and skilled to contribute in full to the betterment of the quality of life for themselves and others in our technological society.

In an effort to acquaint high school women with the educational and career opportunities available to them in engineering, the College of Engineering at the University of Maryland has offered a summer study course for women.

Women who are currently juniors in high school are chosen to participate in a six-week "Study-in-Engineering" program on the College Park campus of the University. The program is designed to give each participant an opportunity to experience college-level work in engineering. In addition, the participants learn about the role women played in the development of science and engineering in the industrial society in which we live. They develop a greater awareness of their own potential. Through the special "Study-in-Engineering" program, the young women return to complete their senior year in high school with confidence and plans to strive toward the full development of their potential abilities.

Purpose

The purposes of the program are (1) to encourage more women students to consider the field of engineering, (2) to provide an opportunity for talented women students to experience college level study earlier, (3) to provide an opportunity for them to experience college life, (4) to provide a basis for evaluating and perhaps changing their planned senior year in high school, and (5) to provide an experience from which the selected women students can relate and help their peers in making a choice of career or study field.

Selection of Participants

The "Study-in-Engineering" program is offered to select high school women at the completion of their junior year. The selection process requires students to be recommended by their science or math teachers or counselors with approval of their school principal. Over 100 applications are usually received and, of these, 20-25 are accepted. Financial support from industry provides scholarship aid.

The Program

The academic experience is provided through two different courses. One course provides an introduction to engineering science through which students become acquainted with key concepts of applying math and science to engineering problems. Studies include graphical communication as a form for engineering design and product development and the use of the computer in engineering analysis and design. These skills provide students with the basic languages of the engineer. Fortran computer language is taught to allow students to solve simple engineering problems using the computer. Orthographic projection graphs and curve fitting permit the students to develop techniques to graphically communicate and understand engineering design. This first course, ENES 101, is the first basic engineering course required of all students in the College of Engineering. The students are, consequently, immediately involved in engineering study. The textbooks used are: Introduction to Engineering Graphics by Beakley; Graphics for Design and Visualization: Problems Series A by Beakley, Autore and Hawley; and Programming with Fortran IV by Gottfried.

The second course (ENES 121) provides the participants with the opportunity to visit research laboratories on campus and to discuss with faculty the areas of basic research done in the various departments within the College. Tours are arranged to visit the Goddard Space Flight Center, the Western Electric Company, Bechtel Corporation, and the Westinghouse Defense and Electronics plant in Baltimore. Upperclassmen, both male and female, from the College are also brought in as guest speakers to provide the students with information concerning their perceptions of engineering and the curriculum offered here.

The participants have the opportunity to visit and interview successful women scientists and engineers, in an effort to provide role models, i.e., women with whom the students might identify or in some cases emulate. In addition, Kundsins' book, Women and Success and autobiographies of women engineers provided by the Society of Women Engineers are read and discussed. A historical perspective of women's place in society, and specifically science, is provided through Chafe's book The American Woman: Her Changing Social, Economic and Political Roles 1920-1970; Women at Cornell: The Myth of Equal Education, and selected articles from periodicals. Special emphasis is placed on the engineering problem-solving process with some technical applications using Morris', Engineering: A Decision-Making Process, and written reports on different fields of specialization within engineering.

Evaluation Results

The program has been in existence for four years (1975-1978) and the summer program for 1979 is now in its planning stages. The following represents the responses of twenty-four students to the evaluation forms which were distributed on the last day of the 1978 summer program:

Item #1. Students were asked to discuss their initial goals and expectations concerning the program. The majority cited learning about engineering and wanting to explore engineering as a possible career choice as their primary goal, and that they had been able to attain this objective.

A secondary expectation cited was wanting to discover what college life was like. This was also realized. Some of the students mentioned wanting to learn about computer programming and graphics. This goal was achieved in the engineering class, ENES 101. When asked about what expectation had not been met, some students mentioned that not enough time had been spent using the computer.

Comment: Goals and expectation for the program were generally achieved.

Item #2. The students were asked to comment on whether they had changed as a result of their participation in the summer program. The responses in descending order of frequency were:

- | | |
|--|---|
| (1) more confidence in self and ability to adapt. | 6 |
| (2) learned more about self, i.e., attitudes, values, interests. | 6 |
| (3) feel more competent, able to succeed in college. | 6 |
| (4) more accepting of others, broadened way of thinking about others. | 5 |
| (5) more interested in engineering than expected. | 4 |
| (6) fewer doubts about entering a "male" dominated field. | 3 |
| (7) more aware of college life and what it is like. | 3 |
| (8) realized diversity available in engineering. | 3 |
| (9) saw career decisions and factors involved more clearly. | 3 |
| (10) generated and/or changed further career goals. | 3 |
| (11) more independent. | 3 |
| (12) not so concerned about combining marriage and family with career. | 2 |

Comment: It is interesting to note that students felt increased self-confidence, self-awareness and heightened feelings of competency to succeed in college.

Item #3. The students were asked to list three things about the Program that were beneficial to them.

The responses in descending order of frequency were:

1. Reports on different fields of engineering assigned to ENES 121.	11
2. Field trips.	9
3. Learning FORTRAN, graphics.	8
4. Talking to other engineers; guest speakers brought into class.	6
5. Meeting other students with similar interests, goals.	6
6. Class discussions in ENES 121.	4
7. Computer problems - flowcharts - taught how to think logically.	4
8. Relationship with instructors.	3
9. Problem-solving/decision-making.	2
10. "Being on my own."	2
11. More sure about choosing engineering as career.	2

Comment: A goal of the program is to acquaint women with the opportunities in engineering. Students expressed overall satisfaction in learning about the different fields of engineering.

Item #4. The students were asked to list three things about the Program that were least beneficial to them.

The responses in descending order of frequency were:

1. None. Program good as is.	8
2. Rushed at end in ENES 101 to cover everything; content should have been spaced out more evenly.	4
3. History of women's place in society; discrimination study.	4
4. Classes too early.	3

Other things mentioned by only one person each were:

Too much reading,

Too much graphics,

Not enough graphics,

Problem-solving,

Chafe's book,

Kundsin's book,

Didn't feel content was the same as regular college classes; didn't learn enough,

Classroom was stuffy,

Commuting,

Being on own gained weight, didn't budget sleep, study, party time well.

Lack of organization first Sunday and Monday of program.

Comment: Complaints about the Program were minimal. The major complaint appears to be lack of sufficient time and the harried pace. This is a problem in summer school in general (e.g., trying to complete all course requirements in six weeks. The complaints about studying women's role in society is interesting. Perhaps the women's movement has achieved some of its goals and young women today feel that opportunities in all spheres of our society are open to them. The directors feel, however, that the study of women's role in society from a historical perspective is critical to keeping women informed and able to move ahead with the progress that has been made since the 1960's.

Item #5. Students were asked to rate their progress on the following objectives by noting "none," "some," "much."

(a) Gaining factual knowledge (terminology, methods, trends).

Students reporting none	0	0%
some	7	35%
much	13	65%

(b) Learning to apply program material to improve rational thinking, problem solving and decision-making.

Students reporting none	0	0%
some	13	65%
much	7	35%

(c) Developing specific skills, competencies and points of view needed by professionals in engineering.

Students reporting none	5	25%
some	11	55%
much	4	20%

- (d) Developing a sense of personal responsibilities (self-reliance, self-discipline).

Students reporting	none	3	15%
	some	10	50%
	much	7	35%

- (e) Discovering the implications of the Program material for understanding myself.

Students reporting	none	0	0%
	some	8	40%
	much	12	60%

Comment: It appears that most of the students achieved progress in the objectives outlined. Five students felt, however, that they had not developed the skills, etc., needed by professionals in engineering. This is understandable since they only had one introductory engineering course.

Item #6. Students were asked to respond to whether they felt that they were treated as regular college students by the faculty and by other students. Eleven said they were treated as regular students by the faculty and nine said they were not.

Those stating that they were not treated as regular college students felt that they were not asked to work as hard as they felt college students were required to work and that the teaching staff was too lenient with them. Others said that they felt as though they were treated as "special" with a great deal of personal attention. The students selected for the program were very high achieving students and may have held expectations that college level work was much harder than what they encountered in high school.

Eighteen students stated that they were treated as regular college students by the other students on campus, only two did not.

Comment: All the students were required to fulfill regular college assignments. The staff became very personally involved with the students in the course of the summer. Care must be taken in future summers to prevent this personal involvement from appearing as leniency and lessened expectations.

Item #7. The participants were asked if they planned to make any changes in their study program for 1978-1979:

Six students said they planned changes while fourteen did not. Those planning changes for their senior year in high school expect to take mechanical drawing, more science, such as advanced placement chemistry, and computer science.

Item #8. This item asked the students if they planned to report on their accomplishments this summer to their high school teachers, counselors and fellow classmates. All the students intend to tell others about the

program. All felt that their peers should know about the program for next year.

Item #9. Students were asked if they planned to continue with engineering study in college. Ten responded "yes," three responded "no," and seven were "unsure."

Some other fields that the students mentioned that they would consider instead of engineering were medicine, dentistry, architecture, chemistry, physics, math, accounting and computer science.

Comment: The opportunity to do reality testing is one of the strengths of the program. Engineering study requires commitment which everyone may not desire.

Item #10. The participants were asked if they planned to continue their education at the University of Maryland and if not, what other schools they were considering. Four students said they planned to attend the University of Maryland and eleven were unsure. Other schools mentioned were Johns Hopkins, Columbia, Penn State, Georgia Tech, Drexel, Duke, Purdue and Virginia Polytechnic Institute.

Item #11. What three things could you do to help other women students have a better concept of the field?

Very few of the students responded to this item. It appears that this question was worded poorly and the students were unable to answer it. Therefore, no more attention will be paid to this item, and it will be eliminated from future questionnaires.

Item #12. This item asked the students to make any comments or suggestions to help improve the program. The responses in descending order of frequency were:

- | | |
|---|---|
| (1) More field trips, graphics and classroom sessions. | 7 |
| (2) No suggestions -- terrific as is. | 6 |
| (3) More time needed. | 4 |
| (4) Better organization during first two weeks. | 2 |
| (5) Encourage people to live on campus. | 2 |
| (6) Put girls in dorm on same floor. | 2 |
| (7) Less reading emphasis on history of women's place in society. | 1 |
| (8) Fewer reports. | 1 |
| (9) Oral rather than written reports. | 1 |

Comment: Some of these suggestions have previously been noted in the discussion of the other items on the questionnaire. The students appear to have enjoyed learning graphics, the class discussions and the field trips.

Reflections and Recommendations

The program is functioning well as it is designed. It encourages participation by very capable women students. By limiting the number to two from any school, maximum participation across the State and in surrounding states is encouraged. The program provides students with challenging and interesting college experiences prior to their senior year in high school. These women, in turn, become leaders and role models as they return to their senior year of study in high school.

The directors of the program have recommended that the Women: Study-in-Engineering Program be offered again in the summer of 1979. The number of students should remain small in size (20-25) to provide ample opportunity for class discussion and the ability to visit small research laboratories. Students will be encouraged to live on campus so as to participate as fully as possible in campus life. Living on campus will not be mandatory, however.

The Program has been funded for the past four years by contributions from Western Electric Corporation, Kelly-Springfield Tire Company, Gulf Oil Corporation, Bechtel Power Corporation, IBM, Armco Steel, Westinghouse Electric Company and Bethlehem Steel. The cost of the program was kept relatively low because teaching staff was paid from summer school teaching funds. Prior to 1978, the instructors added the extra teaching responsibilities to their regular administrative duties and teaching salaries were not needed. Support monies from industry were used for scholarship assistance for the students and for some administrative costs. It is anticipated that continuing corporate support will enable the College of Engineering to offer this worthwhile program.

A CONGLOMERATION OF PROGRAMS TO ENCOURAGE MINORITIES TOWARDS PHYSICAL SCIENCE CAREERS

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Over the past five years, a number of activities to encourage secondary school girls and minorities to enter physical science careers have been carried out at Melbourne High School in Melbourne, Florida. While these activities have been open to all students, special emphasis has been put on presenting both women and minorities as role models who were currently working in physical science careers.

The program has evolved from the need of the Melbourne High physics and chemistry teachers to increase enrollments in their classes or face the possibility of losing their science teaching assignments. In the early 1970's the U.S. space program was quickly grinding to a halt and interest in the engineering and the physical sciences was probably at its lowest point. Melbourne High was particularly hard hit as students in this area, only thirty miles from Kennedy Space Center, came predominantly from families employed in technical and scientific work with the space program. The inability of these discharged space workers to find re-employment in science and engineering left their children embittered with these career fields. As a result, enrollments in high school courses leading to such careers plummeted. To increase these enrollments, some means had to be found to make students aware of careers beginning to open in the applications of space technology to the emerging and more popular energy and environmental problems.

Physical Science Career Programs

The physics teacher author had just returned from a summer 1974 program on technical, environmental and social considerations of nuclear power generation at the University of Florida College of Engineering. From the expanded awareness of the many areas of new energy technology which were being developed in Florida came a plan to share this encouraging information with the students. The 1974 Symposium on Energy Sources and Their Applications in Florida included speakers from all over Florida on hydrogen energy, nuclear and fossil power plants, offshore power systems and the new two- and four-year engineering technology curricula.

Later, National Aeronautics and Space Administration (NASA) and Energy Research and Development Administration (ERDA) films on these subjects were used in the science classrooms to help students gain basic understanding of the processes involved. Many science classes, both physical and biological, from the most basic classes for students with minimum science knowledge and poor reading abilities to the most advanced college preparatory classes, all participated. To provide students at Melbourne High with many different means of achieving their educational goals, classes are multi-phased (organized on ability and prior knowledge levels) and upgraded (contain students from all grades -- 10, 11, 12).

The physics and chemistry students followed up this study of nuclear power generation with a field trip to Florida Power and Light's Hutchinsons Island Nuclear Power Plant. After donning hard hats, students had a rare opportunity to go down into the reactor pit just a few weeks before fuel was loaded and continue up to the catwalk around the top of the containment vessel.

In January 1975 the school occupational specialist and a county career specialist assisted in carrying out a job familiarization unit for students enrolled in physical science classes with a minimum of science knowledge and about fifth-grade reading levels. Students had opportunities to explore their own interests, abilities and values before participating in a series of films and activities selected to describe physical science careers on their job capability levels. Students then wrote their own resumes, filled out job application forms and had mock job interviews. Vocabulary needed for these activities was stressed. Students in these classes were probably 60% black and about equally divided by sex. Many of the highest achievers in these classes were girls. At that time, seven classes of this level physical science were taught; this year only two very small classes were enrolled; next year no such class is scheduled for lack of student interest during pre-registration. The reasons for such little interest have not been determined, but it may in part stem from reduced school enrollment and re-districting for a newly built high school.

In May of 1975, two busloads of these physical science students were taken on a special all-day educational guided tour of Kennedy Space Center. NASA provided many opportunities to observe physical science related careers at all levels.

Because the entire 1975 physical science careers program had been such a success, the 1975-76 program expanded to include over forty one-hour programs in two days. As many as four programs ran concurrently. Assisted by the school occupational specialist, the science department hosted programs at all levels: engineering, semi-conductor assembly; telephone operators, repairmen, linemen and engineers; firemen; quality control; astronomy; nuclear engineering and plant operators; NASA co-op program; aviation; technology; computers; solar energy; medicine and medical technology to name a few. Over fifty members of the local technical, academic and industrial communities were involved.

In spring 1976, math, chemistry and physics students toured technical facilities of the Air Force Eastern Test Range, including communications and radar installations, technical computers, film processing, drafting room, and optical lab. Some students saw for the first time the equipment on which their own parents worked.

The physical science classes that year took a trip to Third Century America, the Bicentennial space exhibit at Kennedy Space Center. Many applications of space sciences to current problems were on exhibit. Once again, these students, having been prepared to seek answers to specific questions before leaving the classroom, behaved properly and gained considerable information about work in the space programs.

Because of the tremendous amount of work involved in the previous physical science career programs, the sponsor teachers limited the December 1976 symposium to one program per class period for just two days. Criteria used to select topics were areas not covered in regular classes or areas about which students had asked many questions. These speakers were asked to describe their educational preparation, career activities at present work, and to forecast opportunities in their field. Students were amazed at the number of speakers who stressed the need for students to master reading, writing, and basic mathematics skills in high school in order to succeed at jobs of all levels. Once again, energy, environmental concerns and new technologies were the main topics -- oceanography, searching for energy in North America, semiconductors, computers, earth resources satellites, and the ERDA energy environment simulator.

During Engineers' Week in February of 1977, 1978 and again in 1979, Melbourne High physical science teachers accepted the invitation of Florida Institute of Technology (FIT) to have their students visit its exhibits, demonstrations and lectures. The FIT Science Education Department even provided transportation when high school field trip funds were cut. These trips have provided useful interaction between secondary students and college students and faculty. Sophisticated lab equipment has interested the students and held out many physical science career possibilities.

The 1977-78 physical science career program was very short -- not from lack of student interest but from lack of sponsor teacher time. The three events were: the FIT chapter of Eta Kappa Nu, electrical engineering honorary, taught the use of pocket calculators for science students; a neurologist described diagnosis using CAT X-rays and follow-up treatment and results; and an ERDA woman educational specialist provided four traveling lecture-demonstrations on energy.

During Vocational Education Week in February, 1978, a Job Fair was held at Melbourne High. Over forty programs on careers of all levels and in many areas were presented. Most careers described were in the physical sciences, primarily because efforts to get teachers of other disciplines involved in inviting speakers have not been very successful.

Special mention should be made here of several programs directed toward minorities. NASA at Kennedy Space Center each year sends the black woman who is director of its co-op and minorities programs. She is very effective in describing the many opportunities NASA offers for minorities. The FIT Student Chapter of the Society of Women Engineers has provided women engineering students as role models. A women electrical engineer from FIT School of Technology described its curricula and employment opportunities. Women also have discussed their careers in computers, banking, stock brokering, medicine, and the civil service.

This, then, is a summary of the programs intended directly to provide career awareness. In addition, a number of other activities have indirectly served this purpose.

Building Things That Go

Building and firing model rockets has proved to be one of the best activities to get students of all ability levels of both sexes personally involved in sciences. Both the physical science and the college prep physics classes have been equally enthusiastic participants the years that every student was required to build his or her own rocket according to technical guidelines. Extra credit was given to those students who built firing and tracking equipment and to upper phase students who served as advisors to the lower grades. A girl built the finest firing system ever assembled by one individual in spite of the fact that her achievement in physics class was not the best. Girls' rockets flew just as well as boys' -- to the boys' chagrin! Girls also excelled in tracking and reducing data. The firings climaxed units of study on why rockets fly and on model rocket safety. The classes were divided into groups and rotated duties until each group had performed every operation.

On May Day, 1979, steam boat races were held in a pond on the campus. All boats had to be propelled solely by a steam engine made of a soda pop can with no more than two candles for heat power. Some boats promptly sank, others went in circles and a few crossed the finish lines.

Programs in the Classroom

Each year the physics classes study "What A Citizen Needs to Know About Energy." A notebook is made of clippings describing operation of sources of energy other than petroleum. Students write a short abstract of each article and choose the one best for immediate use and the one which will not be ready for use until later. They also make a notebook of three pro and three con articles on the use of nuclear fuel for power generation; then they summarize their own positions, based on the articles. Finally groups lead discussions on environmental, political, social and legal problems involved in solutions to the energy crisis. This is an attempt to teach students a method for making informed decisions on scientific questions which arise in the community.

Physics class students also choose a modern application of physics, such as lasers, semi-conductors, heart pacers, and have seven minutes to describe its operation to the class using charts, diagrams, photographs and the equipment itself. Each student gives the class one question which it should be able to answer after he finishes.

Astronomy is a part of the Project Physics curriculum but not the other level physics course. So students select an astronomy topic from a list provided and give an oral report on black holes, telescopes, orbital parameters, the celestial sphere, the changing calendar, binary stars, constellations, etc.

Physics students learn how modern communications and audio-visual equipment work. Groups select such topics as magnetic sound or video tape recording, cameras, movie projectors or FM radio, do research, and then present short oral reports on the operation of equipment. An actual operating demonstration must accompany the report.

Each physics student also chooses three topics of interest to him or her, suitable for a physical science research project. The student is guided in a search of the current literature to select the one on which he can then prepare a review of the literature, problem statement, and project proposal. Some continue with a design of the experiment. In connection with this, students are also given several short scientific articles to read, abstract and critique.

Obviously, there is not time to carry out all of these activities every year. Several are selected to fit current interests or events. This year the unit on "What A Citizen Needs to Know About Energy" was completed just as the Three Mile Island nuclear controversy broke. As a result, many students were able to make well-informed comments much better than the average adult citizen.

Science Research is a regularly scheduled class at Melbourne High. Extra funds are provided by the county for student materials and for a small supplement to teacher pay. Both teachers and students must put an extra four hours per week after school hours in the research area. Students are taught how to select a good science research project, complete the literature search, formulate hypotheses, plan the experiments, collect and analyze the data, and draw conclusions. All students are expected to participate in at least three related activities: Science Fair, Science Talent Search, Florida Junior Academy of Sciences Symposium, Westinghouse Talent Search and other available competitions. As part of the class, students learn how to prepare all materials needed for their entries. Science Research is also taught in the regular Melbourne High summer academic program.

The Real Conglomeration -- In The School

A number of other science-related activities which occur in the classroom or are connected directly with the school will be discussed briefly here.

The Astronomy Club has had a very small but dedicated membership, even including students from the local parochial high school which does not have a club. Two years ago the Club raised funds and purchased an eight-inch mirror; and some parts. By scavenging some old junk telescopes, they were able to assemble an eight-inch reflector telescope with the assistance of a retired professional astronomer who serves as the Club's technical advisor. Each year since then, additions have been made to improve the telescope. Club members provide students of the whole school views of special astronomical events or sometimes just of sun spots during lunch.

Each student in the physics classes is expected to bring on Monday a current news item on a physical science topic. Discussion often follows. Those who make these reports earn extra credit; students are also encouraged to bring articles suitable for the bulletin board in the classroom.

A special bulletin board is maintained with information on physics scholarships, summer programs and other opportunities.

Magazines are available in the classroom for students to browse, especially "Astronomy," "Natural History," "Popular Science," "Science News," and some professional technical journals of more general interests. NASA, and more recently the National Air and Space Museum, provide very popular literature especially connected with air and space activities. Back issues of "National Geographic" are also popular.

Through the effort of the physics teacher, the Melbourne High library has acquired a new science technology encyclopedia and other new science reference materials. A few new audio-visual materials have also been acquired through repeated requests.

Another regular part of the Melbourne High curricula is the Independent Study or I/S program. Under the direction of a teacher skilled in inquiry and research techniques, the student selects a topic on which he will make a one or two semester in-depth study. The student obtains a faculty preceptor who guides and evaluates his study project. Either a written or oral report or a completed project must be presented at the end of the semester. Many talented students use this method to study individually courses which are not in the regular curriculum. For the past three years, the author has used her planning period to teach Physics II using a sophomore college text to groups ranging from two to seven I/S students.

Spring open house at Melbourne High provides an opportunity for the community, especially incoming students and their parents, to look over the school and to discuss classes with the teachers. Physics student volunteers have served as physics tour guides and set up, operated and taken down the equipment demonstrations. Each year the Astronomy Club has drawn large crowds with its telescopic views of the sky.

The Conglomeration -- Outside the School

Local technical societies regularly invite two students and a teacher as their guests to their monthly dinner meetings. An attempt is made to select students who have an interest in the program being presented usually through a research project or a classroom interest.

The Canaveral Council of Technical Societies (CCTS) provides opportunities for students who place second in the yearly science fairs to exhibit their projects during its Space Congresses. These projects then are judged and prizes given. Students also serve as aides during the Congresses and thus can hear the technical sessions. The CCTS has purchased payload space on the Space Shuttle and is currently sponsoring a contest to select those projects which will be flown.

Florida Institute of Technology has been a tremendous supporter of Melbourne High. Its library and technical information search services are open to any student advanced enough to use them. A high school student recommended by his principal may take without cost any course at FIT for which he is qualified. Only if the student wishes to use the credit towards a college degree there or elsewhere is tuition charged. The Science Education Department serves as a clearinghouse in finding professors to provide

counsel and advice and in supplying information, equipment and assistance of all kinds to both faculty and students of Melbourne High.

In addition, FIT has several summer research programs in which students assisted faculty members with their research projects for part of the day and either took classes or worked on their own projects the rest of the day. Some even earned college credits.

Last summer a one-week program in science research for middle school students was held at FIT in response to requests by the middle school science research teachers. It was planned to help students select good projects and to form suitable hypotheses. Each middle school student had a FIT graduate student advisor who worked with him or her in completing these goals.

Both FIT and Brevard Community College (BCC) offer an early-admissions program in which gifted secondary students may begin their college careers while completing their few remaining high school requirements. One girl graduated from both Melbourne High and BCC within a few weeks.

NASA at Kennedy Space Center and many industrial contractors there as well as local industries have been very generous in providing information and assistance from their technical staffs, in loaning equipment and audio-visual materials, and in permitting the use of their lab facilities. NASA permits qualified students and teachers to use its computerized technical literature search. Both the NASA and ERDA film libraries are used extensively by physical science teachers.

RCA at Patrick Air Force Base provides opportunities for selected minorities to take a ten-week class in some fundamentals of engineering. Students are transported to the class where they associate with engineers, learn about engineering preparations in school and build a small computer which they use to solve problems.

NASA at Kennedy Space Center provides many opportunities for minorities. One program matches minority students and their career interests with project professional openings there. Students work the first summer, then attend college their freshman year. After that, they co-op until college graduation. Each year, as a result of extensive publicity within the school, two to four Melbourne High students are selected for such engineering and scientific openings. They return to spread the word to high school students the following years.

The Junior Engineering Technical Society (JETS) each year sponsors the National Engineering Aptitude Search which is designed to indicate the probability of success in engineering college to those students who take the tests. Melbourne High students are encouraged to take the test and to have the scores reported to engineering or science colleges when they apply for admission.

JETS also sponsors summer programs on college campuses to explore the work and educational preparation of engineers. A similar program is sponsored by the Engineers' Council for Professional Development and is called MITE. Both of these programs are directed primarily towards minorities.

The list of these programs published by JETS also includes similar programs under various other sponsorships.

The Florida Section of the Society of Women Engineers each year has a fall symposium for women in engineering and science. The November 1978 symposium included for the first time a full-day program for high school girls, their parents and counselors. Well over one hundred attended from all over the state to meet women engineers, learn about engineering careers and gather information. As a result, the high school program will become a permanent part of this event. The Society also awards certificates for excellence in math and science to high school senior girls in every high school in this county; this is a part of the national activities of the Society and its career guidance committee. Scholarships are also available.

National Science Foundation funds a number of summer science programs for secondary students. These opportunities are published each spring in "Student Science Training Projects." Many stress minority participation and usually give them preference, especially in obtaining scholarships. These programs are a combination of classroom work and lab investigations with a faculty member. The University of Florida has held such a program for many years but limits each high school to just one participant each year.

Conclusions

This, then, is the conglomeration of programs at Melbourne High to encourage minorities to enter science and engineering careers. It is obvious that the technical, academic, industrial, governmental, and scientific communities provide more opportunities than any one teacher of a school can ever use. But selection of the most useful for a given year, provides a vast range of assistance that is absolutely necessary if effective programs are to be carried out.

Several efforts have been made to evaluate the usefulness of these conglomerations presented to Melbourne High students. Students have been asked to rate the symposia programs according to the amount of useful information provided, by their relevance to the students' interests and by their value in making career decisions. The majority of students who attend, usually about thirty to forty percent of the student body, report that most of the career information in the programs is valuable and that these programs should be continued.

The only tangible evidence that at least a few of these programs may be encouraging minorities as well as all students at Melbourne High towards physical science careers is this one little statistic. The enrollment at Melbourne High, as a result of community changes, has dropped from 2,294 students in 1973-74 to 1,234 students in 1978-79. At the same time the percentage of these students enrolled in physics has more than doubled from 2.7% to 5.6%. In addition, the percentage of physics students who are minorities has increased from 23% to 36%.

On this basis, the Melbourne High programs must represent a step in the positive direction toward encouraging minorities towards the physical sciences.

RCA's MINORITIES IN ENGINEERING PROGRAM

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A nationwide effort to correct the disparity in minority participation in engineering has spawned a wide variety of educational and motivational programs designed to encourage greater interest in engineering among teenage minorities. Industry, in addition to supporting the national effort, offers an ideal environment for exposing young people to the facilities and people involved in the engineering process. It is not surprising, then, that grass-roots programs have proliferated in industry and have proved at least modestly successful in encouraging minority involvement. This paper describes a corporate program developed in RCA to support the broad goals of the national effort.

THE PROBLEM

Discriminatory practices in higher education virtually barred minorities from the professions prior to World War II. Since that time, however, this country's need for more professionals has precipitated a complete turnabout in approach toward the previously untapped resources among minority groups. Indeed, since the middle 50's, minorities have been actively sought after by colleges and universities, especially in programs leading to the professions.

Despite the current opportunities, however, minority participation in the engineering profession remains at a disproportionately low level (see Table 1).

Table 1

Participation of Minorities in Engineering as Compared
to Percent of Total Population (1970 Figures)

	% of U.S. Population	% of U.S. Engineers
Blacks	11.4	1.2
Spanish surnamed	4.4	1.6
American Indian	0.4	0.15
Oriental	1.1	2.9

The reasons for this chronic under-representation are many, but three attitudinal factors appear to be dominant:

- ° Role Models -- Few minority high school students have relatives or friends who are engineers and who could influence and guide them toward an engineering career.
- ° Relevance -- For minorities, engineering has not been considered in the same light as medicine, law, or education.
- ° Stability -- Periodic layoffs in the aerospace industry during the 1960s and early 1970s have created a view of engineering as a field with unstable employment.

The associations required to develop role models can be built, and they will come with time. The other two factors are particularly unfortunate in view of the weight of evidence supporting engineering as a relevant and stable profession. Indeed, few fields of endeavor can impact society and the way we live to the extent possible within engineering; the needed advances in energy, transportation, and housing will depend very heavily on technology and those who understand it. And although engineering is known as a well-paid profession, it is obviously not so widely known that engineering unemployment has historically been substantially below the national average. Perhaps even more important, approximately 60% of industrial executives are engineers by training. Clearly this kind of potential for upward mobility should make engineering especially attractive to minorities.

THE NATIONAL EFFORT

The national effort to increase the participation of minorities in engineering is currently directed by the National Advisory Council for Minorities in Engineering (NACME). NACME is sponsored by the National Academy of Engineers and its members include representatives from government, education, and industry. Among the objectives NACME has developed is one that is extremely challenging -- that of increasing minority enrollment in engineering schools by a factor of 10 between 1972 and 1982. If this goal can be realized, it will bring minority representation in engineering to parity.

Although there have been significant gains, enrollment results to date have been running below those anticipated by the original plan. As shown in Figure 1, minorities represented 8.5% of total freshmen engineering enrollment in 1977, as compared with the target of 11.8% for that year. The disparity, however, is not due to a lack of interest in engineering among minorities. What has happened is that the total engineering enrollment has grown at a faster rate than expected. In 1972 the optimistic forecast for total freshmen enrollment in 1977 was 65,000; the actual enrollment that year was 88,780. So even though actual numbers of minority freshmen enrollments were in line with the original blueprint, the yardstick used for determining the plan has expanded beyond anyone's expectation (see figure 2).

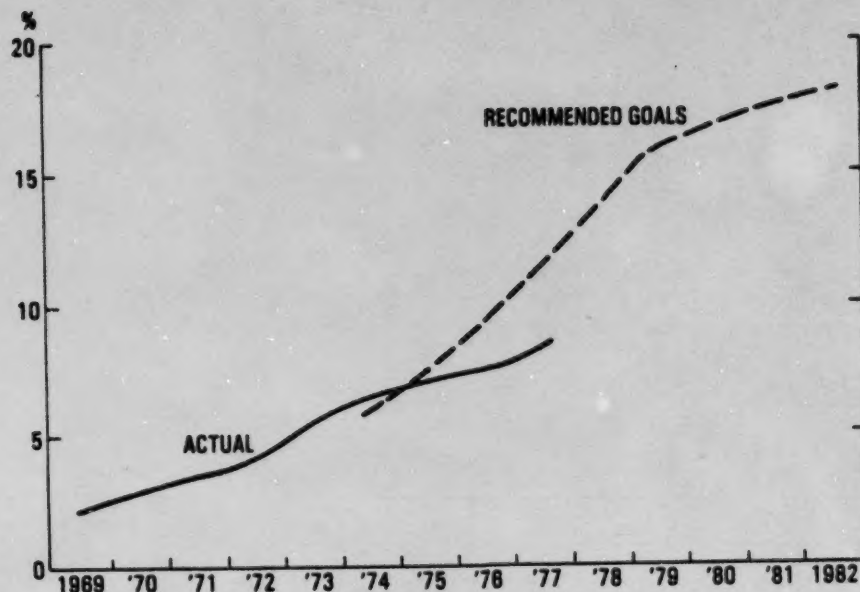


Figure 1. Minorities as Percent of Total Freshmen Engineering Enrollments

The original plan did not include a year-by-year forecast for minority graduation as it did for enrollment, but it envisioned parity in 1987 in graduation as a result in parity of enrollment in 1982. A very important contributing factor, of course, is the average year-to-year retention rate of minority students. As shown in Table 2, the average has increased from 44.3% in 1970 to 78.2% in 1974, reaching parity with these averages for all students.

RCA's MINORITIES IN ENGINEERING PROGRAM CONCEPT

The RCA Minorities in Engineering Program (MEP) was created in 1975 when Robert M. Sarnoff, then Chairman and Chief Executive Officer of RCA, became active in the early NACME planning effort. He wrote a letter to the heads of all key operating divisions in which he expressed his concern over the low participation of minorities in engineering at RCA. The letter initiated an RCA effort that was to be coordinated by corporate Research and Engineering with the assistance of Industrial Relations. All engineering organizations were encouraged to develop grass-roots programs in their locations. A corporate committee was formed to develop a broad program approach that seemed appropriate to RCA. This committee reached two basic conclusions.

First, it was decided to identify minority students with interest and aptitude in the engineering profession, to give them an idea of what is involved in pursuing an engineering career, and to provide them with role models.

Second, it was decided that each facility would develop a program consistent with its own interest and operations.

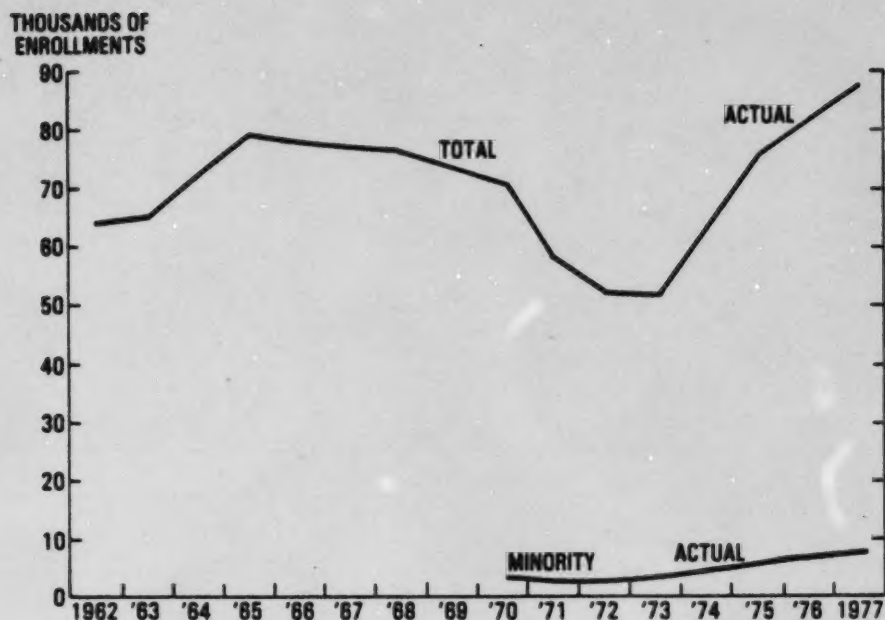


Figure 2. Engineering Freshmen Enrollments

Table 2

Average Year-to-Year Retention Rates, 1970-1974

Date	Average Year-to-Year Retention Rate - All Students (%)	Average Year-to-Year Retention Rate - Minority Students (%)
1970	50.0	44.3
1971	51.4	45.0
1972	60.5	48.6
1973	64.4	55.3
1974	77.3	78.2

Source: Committee on Minorities in Engineering, Assembly of Engineering Retention of Minority Students in Engineering, Washington, DC; National Academy of Sciences, 1977.

This approach was formalized as the RCA Minorities in Engineering Program (MEP) in mid-1975, just two weeks after Mr. Sarnoff's letter spelled out the goals and characteristics of the program. Each location was to name a coordinator and technical director to determine which schools in the area should be approached, and then to make arrangements for the identification of appropriate students to participate in the program.

Each location was responsible for developing the program to be presented, proposing it to the local high schools, and carrying it out. Corporate staff supplied suggestions on how to develop and run such programs and provided materials that might be used. Figure 3 shows the structure and responsibility flow of the corporate program. Within a year the RCA Minorities in Engineering Program was set up and running at 14 different RCA locations. In the typical RCA program, a group of local high school students (ranging from six to fifty, depending on the size and location at the facility) is brought to the company for 10 to 15 half-day sessions held every two weeks. Participants are selected by their schools on the basis of general criteria supplied by RCA. They are minority students (primarily black) -- sophomores, juniors, and seniors.

RCA's MEP Program was originally visualized as an after-school activity, but the high schools have been so supportive of the program that, at their request, classes at most locations are scheduled during school hours with students receiving credit for attendance.

PROGRAM CONTENT

Each location has developed its own special program, with differences reflecting such factors as the plant operations, product lines, and the numbers and types of engineers employed. The most successful parts of the program have been activities in which the students can actively participate, i.e.:

- ° Simulation games where groups of students experiment, and guided design exercises that lead them through the disciplines of problem determination, analysis, and decision-making for problems of general interest.
- ° Kit fabrication - building a technical product such as a scientific calculator, a radio, or a digital clock, and learning how it works, what it can do, and how to use it.
- ° Microprocessor programming for various television games.

A typical MEP course structure is shown in Figure 4.

LOCAL ENGINEERING COORDINATOR

LOCAL IR COORDINATOR

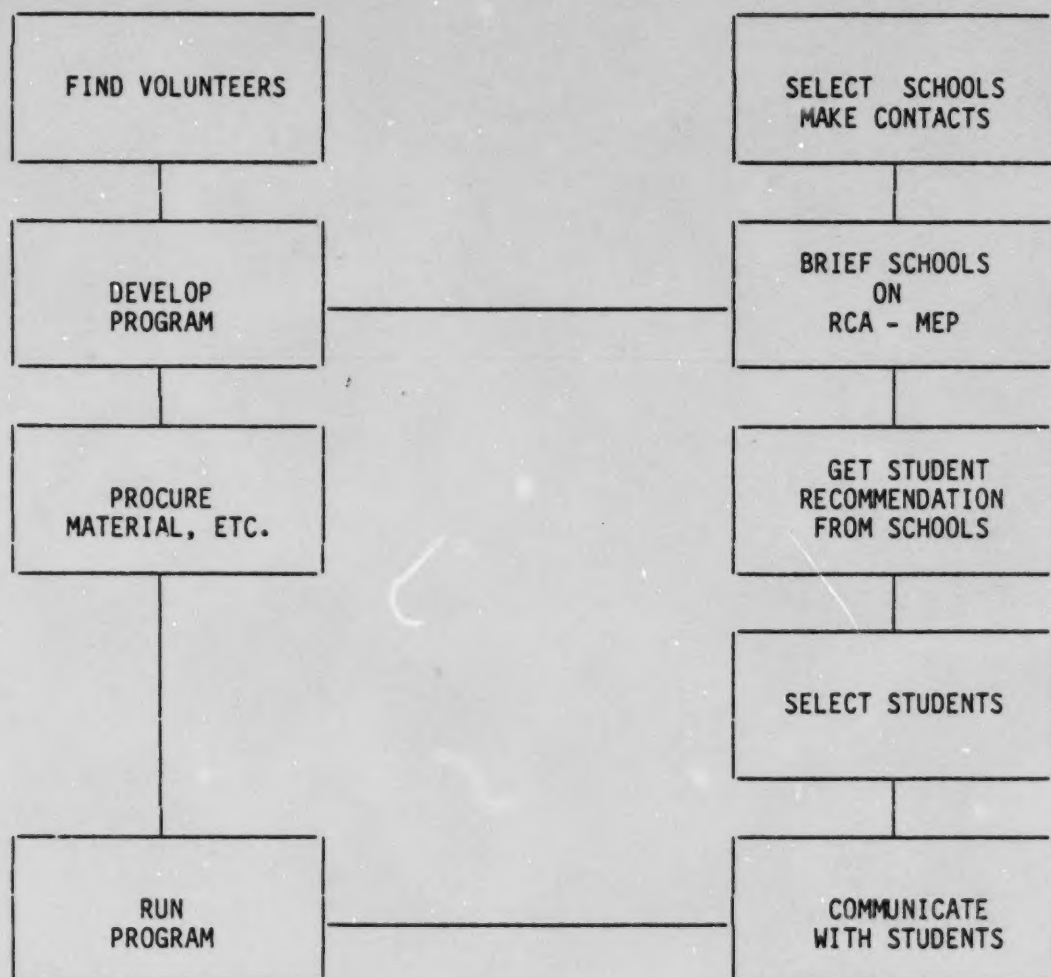


Figure 3. RCA MEP Responsibility Flow Chart

EXPERIENCE GAINED TO DATE

Students have contact during this program with engineers in the classroom and at regular work locations. An attempt is made to keep in touch with students to help them to continue to learn about engineering. In addition, the company has been able to employ many of the seniors in summer jobs. Some locations have developed special summer internships under which students have been hired for eight weeks to assemble a product which is then donated to local schools. In the process they are learning to specify, assemble, and perform many other engineering functions.

Session	Title	Handouts to Students	Instructional Aids	Student Participation
1-4	° Introduction to MEP ° What is an Engineering Career	Brochures and Notes	Movie "Conceive It, Believe It, Achieve It" and Viewgraphs	Class Discussions Guided Design Problem
5-8	Introduction to Microprocessors and Micro-computers	Notes	COSMAC VIP (Microcomputer)	Exercises with Binary Arithmetic and Binary Decimal Conversion; Program COSMAC VIP
9-12	Construction of Kits	Kit and Instructions		Build Kits
13	Students-Parents Dinner	Certificates		Students bring Parents

Figure 4. Typical Course Outline

It has been a thoroughly enjoyable and satisfying experience for everyone concerned -- students, RCA participants, and school personnel. And these attitudes are reflected in the statistical program results: 92% attendance, 10% attrition, and 71% of seniors accepted for college engineering programs.

Each year RCA surveys the students completing its Minorities in Engineering Program for clues to its effectiveness and insights into means for improvement. The results obtained from these program evaluations have remained essentially the same each year and have indicated a significant impact on student career interests in engineering. Table 3 summarizes the overall results.

THE OUTLOOK

The outlook for RCA's Minorities in Engineering Program is excellent. This is shown by the attitude and reaction of students, schools, and program coordinators. The students have shown no reluctance to participate and raise questions. They have found the program interesting and effective. The schools participating in the program have been enthusiastic and cooperative. They consider this program valuable for career development. The cooperation of school officials is shown by the fact that they provide all transportation and, in most locations, give credit to the students for their participation in the program.

Table 3
Evaluation Results, RCA MEP

	MEP Effect			
	A lot	Some	Very Little or None	Total
Increased understanding of engineering career	61%	35%	4%	100%
Stimulated interest in engineering career	40%	58%	2%	100%

	Career Interest Indicated	
	Prior to MEP	After MEP
Undecided	27%	4%
Non-technical	18%	18%
Science	11%	6%
Engineering	36%	64%
No Answer	8%	8%
Total	100%	100%

A wealth of experience accumulated during the past four years is being used for planning the programs for the coming school year. The interchange of experience between different locations, coordinated by RCA Corporate Engineering, now allows all locations to concentrate on the best features evolved to date.

Two aspects may be considered key factors in the continuing successful implementation of the program. First is involvement of parents and school officials. We have found that the acceptance and effectiveness of the program increase directly with every action taken to bring parents and school personnel into closer identification with the objectives. The second factor, of course, is management support. Fortunately, RCA's top management has shown continued support of the program, regardless of the short-term business. Each succeeding Chief Executive of RCA has been enthusiastic in giving corporate sponsorship to the program. Edgar H. Griffiths, RCA's President, has written personal letters to each coordinator and met with them in their annual planning meeting to applaud their past accomplishments and to encourage them to expand their programs. This genuine, overt corporate effort and support to increase minority participation in engineering has assured program continuity and on-going encouragement to those assisting in the effort.

LEARNING THROUGH AVIATION

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Just seventy-five years ago, on the wind-swept sand dunes of North Carolina, Orville and Wilbur Wright opened the curtain on a drama that is still being played. Among the myriad influences of their aviation pioneering, the impact of the airplane on education in general and learning in particular represents the central focus of this presentation.

It is generally accepted that the lag between the appearance of a new technology and its adaptation within the educational system takes at least a generation. Educators cannot be faulted on this score where aviation is concerned. On December 17, 1903, the brothers Wright opened a new era of transportation, communication and education. Unlike other technological innovations, educators responded to the challenges of aviation within five years.

In 1908, physics teacher Mr. H. LaVonne Twining of Polytechnical High School in Los Angeles, California, appears to have been the first educator to capitalize on the inherent interest in man's attempts to fly and use flight as a motivational and educational tool. Within two decades Galt High School, Galt, California, had established a flight training program that later was expanded into a junior college program.

Today, several thousand high schools and hundreds of colleges and universities teach aviation. The central thrust of this paper is not on teaching people about aviation or to fly, rather it describes some innovative techniques whereby the study of aviation, including both actual and simulated flight, is used as a means to other educational ends. In short, learning is facilitated by the use of aviation as a theme or motivator for the study of other subjects, including the accomplishment of basic skills.

Many imaginative teachers have capitalized on the interest of youngsters in aviation to get them to study a variety of subjects while pursuing their basic interest in flight. However, no careful, scientifically planned and objectively documented study of the use of aviation to facilitate learning had been done until 1967. In that year, a landmark project was initiated in the Unified School District in Richmond, California. In addition to significantly touching the lives of the twenty-five disadvantaged area youths who took part in this program, the results of the Richmond project have influenced school and college programs throughout the nation. Basically, the so-called Richmond Project was . . . "an innovative educational experiment which used a light, single engine airplane to generate basic instructional and behavioral changes

in an inner city junior high school class. The flight project involved twenty-five disadvantaged areas, thirteen year old boys and their parents, four regular staff teachers, two pilot instructors and a college student tutor."¹

Among the descriptive characteristics of the group, the project personnel described the students initially as: low and underachieving, having negative self-perception, behavior problems, poor attendance, truancy, and having a high rate of suspension and grades too poor to qualify for college entrance.

The Richmond authorities were interested in doing a research study to test the hypothesis that the use of actual flight and the associated study of regular class subjects in the context of preparing to fly, navigate, etc. could be verified as contributing to attainment of several worthwhile educational objectives. Thus, the research study was designed with the following in view.

Research Objectives included a determination of the value of the flight program in terms of increased motivation. That is, the extent the flight program has succeeded in: 1) motivating the students to achieve academically; 2) motivating the students to attend school more regularly; 3) motivating the students to become involved a greater percentage of their classroom time in instructional and less disruptive and resistant behavior; 4) elevating the level of self-esteem and aspiration of the pupils; 5) improving the chances of higher education for the pupil; and 6) altering the perception of the teachers and parents of these youths as regards their scholastic ability.

The group selected for the flight program had the following characteristics: 1) all male; 2) 80 percent black; 3) average age 13.3 years; 4) a resident of the disadvantaged or 'target' area for a minimum of five years; 5) low and underachievement as measured by standardized tests and grades in academic subjects; 6) I.Q. scores ranged from a low of 78 to a high of 104; 7) one or more significant behavioral problems associated primarily with school, and/or family background. This group was matched with a control group at another junior high school.

Experimental group students were found to range from average to below average in reading ability. In no case did any of the original group evidence a very good ability in reading.²

¹ Lee Conway, Learning Through Aviation Report #1, Department of Transportation, Federal Aviation Administration, Office of General Aviation, Washington, D.C. 20591, p. 1.

² Ibid, pp. 1-2.

One value of this study is that a control group of students was matched with the Flight Group. The Flight Group was, as evidenced by interviews as well as attitude testing, shown to be characterized by disaffection with school and the education system, low self-confidence, poor self-esteem, little faith in the future and a belief that teachers are prejudiced. The control group represented a nearly opposite series of beliefs.

By the end of the first year of the project, the researchers had concluded that their data and observations clearly demonstrated that the Flight Group students had:

- ° developed more positive motivation to achieve academically and make something of their lives
- ° incurred fewer disciplinary problems than the control group
- ° attended school more regularly and earned better grades
- ° showed marked improvement in reading ability³

From the opening of the school year in September of 1967 until the Flight Group advanced into and through high school, it was clear that the project had a profound influence on each student. Details of these effects are spelled out in the report cited earlier along with the Second Report on Learning Through Aviation dated May 1970.

The real test of a program of this type is what happens to the students after graduation from high school. Fortunately, this data is available. In 1975, as a result of support by the Oklahoma State University Education and Research Foundation, the National Aeronautics and Space Administration (NASA) Ames Research Center and the National Institute of Education, Sociologist and Evaluation Consultant Lee Conway did follow-up interviews with the Richmond Flight Group. The areas of the follow-up included academic progress, employment, self esteem, parental backing, sense of mastery. Conway's conclusions include the following:

The many successess of the flight project and its unexpected positive results appear to be caused by the youths' involvement in a high-status activity, elimination of the fear of failure, changed expectations on the part of others in their lives, acquisition of unique skills, and the opportunity for significant achievement in the dominant culture.

This longitudinal study has produced considerable 'hard' data as well as qualitative results supportive of the flight project concept. Former project youths are demonstrably better off than controls in the areas of employment, advanced education and avoidance of deviance. Finally,

³ Ibid, p. 38.

project youths appear to have grasped the linkage between advanced schooling and career potential as their essential and available source of power.

Flight brought a sense of joy to these youths and overcame their pervasive feelings of alienation and worthlessness. Their flight instructor's noncritical, nonthreatening evaluation of their abilities gave them a sense of 'specialness' which overcame the judgmental, negative attitudes to which they had grown accustomed.

Our evaluation data appears to prove that moral and imaginative capacity, not measured achievement or tested intelligence (IQ), are the real defining characteristics of human beings.⁴

Clearly, the ways in which this program touched the lives of the students, parents, instructors and others associated with them is remarkable. But what other influence has this project had?

The concepts that were so well planned and carried out in the Richmond, California, schools starting in 1967 were spread to the District of Columbia School system as early as late 1968 and early 1969 when an imaginative teacher from the Cardozo High School visited Richmond to learn how to adopt some of the techniques in a District of Columbia school.

During 1968, members of the community including parents, labor, education, industry and government were exploring how to use the Richmond techniques to establish an entire high school as a magnet-thematic type program in the borough of Queens in New York City. The result of the study and research clearly pointed to the feasibility of establishing a high school with the entire educational program built around aerospace.

The joint planning efforts of the various groups resulted in a 1969 authorization of the New York City Board of Education to convert the old, traditional and increasingly ineffective Woodrow Wilson High School. After two years of careful planning, the new school was opened in September 1971. It was named August Martin High School. August Martin, one of the first Black airline pilots, was killed flying a volunteer relief flight to Biafra.

The school, since its inception has averaged a daily attendance of more than 90 percent. This is remarkable for the metropolitan New York City area. The student body is 95 percent black. It ranks as the highest level academic secondary school in Queens. The school is attended by students from throughout the city and it is noted for rigorous entrance and performance criteria.

All of the disciplines taught in the school are related, as appropriate, to aviation, space or transportation. The school is very near John F. Kennedy Airport, and many of the various aviation, industry and government agency people associated with this huge international airport work closely with faculty

⁴ Lee Conway, "Classroom in the Sky: A Power Trip for Disadvantaged Youth," Phi Delta Kappan, May 1976, p. 574.

and students. Many students take advantage of a flight option program that is carried out in cooperation with the State University of New York at Farmingdale. The majority of August Martin graduates go on to postsecondary education. Others go directly into worthwhile employment.

Among the many agencies working with the August Martin faculty and student body is the Aviation Development Council of New York City. This is a small, non-profit group which works on behalf of various aviation interests, both private sector and governmental, to foster aviation via education. Among their many successful projects that use the Learning Through Aviation approach is a special program done under contract with the Law Enforcement Assistance Administration. In this program, four hundred and fifty youths, ages twelve to eighteen, are given basic ground school instruction and actual flight instruction of up to ten hours. Each participant has been referred to the juvenile court system and, except for this program, would be processed through the usual correctional institutions.

The results of this program have been remarkable. Young people who had previously shown no interest in school or learning demonstrated an interest in mathematics and science as these are needed tools in learning to fly. The per youth cost of handling such young people through the traditional juvenile justice system is \$14,000.00 per year. By whatever indices one wants to use, this approach merits objective study.

In 1974, Embry Riddle Aeronautical University, Daytona Beach, Florida, was awarded a contract by the U.S. Office of Education to conduct an Upward Bound Program.

The overall goal of the project was to use aviation as a tool to motivate financially disadvantaged high school students to continue their educational experiences into post-secondary education.⁵

The project group met on weekends using the Embry Riddle Aeronautical University dormitories, classrooms, counseling and other resources. Actual aviation oriented studies were used to stimulate improvement in reading, mathematics and science skills. The 1974-1975 group included sixty-five students who met the criteria referred to above. Twenty-one of the group were high school seniors. At the close of the first year project, twenty of the seniors had been accepted for college and the remaining one received post-secondary technical training in the Air Force.

Progress made in other areas included: 69 percent of the total group showed improvement in their school grade point average, 65 percent of the group initially showed reading performance below grade 9 level and 22 percent of this group raised their reading level by the end of the program,

5. Final Report, Upward Bound 1974-1975, Embry Riddle Aeronautical University, Daytona Beach, Florida, August 1975, p. 1.

while 39 percent of the balance of the group raised their reading level by one year. Clearly, measurable progress was made.

This program was continued in subsequent years in both the regular school year and in a summer program. In each instance, positive results were attained. In later programs, actual flying was a part of the program to provide a flying classroom application of ground studies. Impressive advances in language, communication, mathematics and science areas were made.

The most recent nationally significant example of a secondary school which uses an aviation or aerospace thematic approach is the Randall High School in Washington, D.C. This former junior high school in the inner city of the nation's capital is located a short walking distance from the Capital Building. The acronym for this school is RAMS -- meaning Randall Aerospace and Marine Science. The two central themes of aerospace and marine science were chosen because of the proximity of facilities to the school -- Washington National Airport, Andrews Air Force Base, Dulles International Airport, several general aviation airports, the National Air and Space Museum of the Smithsonian Institution, NASA, Department of Transportation, United States Coast Guard, Federal Aviation Administration (FAA), and other local, state, and federal agencies.

From a marine science point of view, the Potomac River is walking distance from the school and the Chesapeake Bay is within relatively short travel time. In essence, the school has been established to take advantage of the local resources. Finally, the experiences of Richmond, California, August Martin High School, Cardozo High School and other programs referred to above have been brought to focus in this project.

The author has been associated with the RAMS project since its inception, serving as the FAA's major consultant to the faculty, staff, community, Board of Education and industry, government and education officials associated with this project. Basically, students in RAMS complete their high school studies in either -- or in some cases using portions of both -- aerospace or marine science.

RAMS students in science class spend time exploring the river banks and cruising in local waters in quest of specimens. Some analyze weather conditions for flight. Art students use model clay or soil dug from local offshore deposits and also create art objects of driftwood or stones. Mathematics classes explore the principles of navigation with power boats, sailboats and airplanes. Teachers in all subject areas think, plan and teach in terms of the river and bay, sound and flight.

The District of Columbia Board of Education has mandated an emphasis on competency based programs and the RAMS concept lends itself to such an approach to education. Furthermore, all offerings are career oriented.

RAMS students develop their listening and speaking skills as they study the language, techniques and work of air traffic controllers and the air traffic communications system. Computational skills are developed as students interpret tidal charts, calculate the Potomac River water salinity, density,

speed and directions of currents. Much of the RAMS study and activity takes place away from the school. Work sites are visited for career information. Actual "hands-on" experience is provided for students in both aviation and marine activities.

A major characteristic of the RAMS approach is to make use of its unique location. A feeling for the resources that are provided by local organizations, government agencies, business and industry and the local community may be noted from the following list of some of the resources that help with the RAMS Program:

Federal Aviation Administration
National Capital Parks' Lightship "Chesapeake"
National Oceanic and Atmospheric Administration
Washington Metropolitan Police Department - Harbor Section
National Transportation Safety Board
National Aquarium
Congressional Flying Club
U.S. Coast Guard Auxilliary
U.S. Navy
Civil Air Patrol - National Capital Wing
Tuskegee Airmen's Association - National and Washington Chapters
University of the District of Columbia -
Aerospace and Marine Science Departments
David W. Taylor Naval Ship Research and Development Center
National Red Cross
Kiwanis Club

Since the first class of RAMS students did not graduate until June of 1978, it is too early to verify the post-high school results for the graduates. However, a September 1977 evaluation study of the RAMS Program reported the following:⁶

- Through planned dissemination activities, the curriculum is useful to inner-city, economically deprived students in the entire Southwest area, as well as city-wide, not only as an alternative mode of innovative secondary school education, but also as a means of putting student capabilities to use in order to solve real needs and problems in real world situations. Program development draws upon community consultants and resources in order to assist the staff team in the planning and preparation of the program. Students and community are active and supportive participants in program development.
- On the General High School Program Questionnaire measuring student attitudes towards schooling, RAMS showed more positive

⁶ I. Goldberg, An Evaluation Study: Randall Aerospace and Marine Science Project Final Report, Division of Planning, Research and Evaluation, Public Schools of District of Columbia, September 1977, pp. 1, 2 and 70.

attitudes than did a control group. Additionally, students who had been in the RAMS program for two years showed more positive attitudes than those who had been in the program for only one year. Two year students also had more positive attitudes than the control group.

- ° A clear majority of teachers rated students as improved in attitudes, behavior, and interest in school and career awareness. Nine of ten teachers rated student-teacher relations as improved.
- ° Student performance in Marine Science and Aerospace field activities was outstanding. About two-thirds of all students participated in activities ranging from Air Traffic Control School, orientation flights, the Congressional Flying Club, the Marine Engineering Program aboard the Lightship Chesapeake, and an Aquarium Maintenance Program at the National Aquarium.
- ° The percentage of students who were certified (in those activities granting certificates) ranged from 60 percent (Air Traffic Control) to 82.5 percent (Aquarium Maintenance) of those participating. This is an outstanding record, since certification required a grade of B or better or a score of 80 percent or higher. The instructors at each facility commented that performance far exceeded their expectations.
- ° It should also be noted that many of these activities emphasized reading, mathematics, written and oral communication along with their substantive content.
- ° Seven of ten teachers rated students as improved in academic achievement even though grade point averages did not change significantly from last year.
- ° The absence rate for RAMS students improved -- dropping from 17.5 percent last year to only 11.0 percent this year. The improvement in Randall absence rates is probably due to the fact that about three-fourths of Randall students are in RAMS this year.
- ° RAMS appears to have had an impact on a number of students in their resolve to stay in school rather than drop out. Eleven of sixteen students said they stayed in school because of the interest in RAMS.

The future of Learning Through Aviation seems assured as Board of Education members of the Detroit and Chicago schools are considering adapting the RAMS approach. Similar consideration is underway at the state level in Colorado as well as in the Denver, school system. Officials of the Coalition of Indian Controlled School Boards are studying the feasibility of using Learning Through Aviation projects to benefit Indian youth.

BEYOND BOUNDARIES: A UNIQUE APPROACH TO AEROSPACE EDUCATION
FOR GIRLS, BOYS, AND MINORITY STUDENTS

Samuel F. Howe
Science Teacher
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Philadelphia, PA

"A small step for man, a giant leap for mankind," with these words Neil Armstrong became the first man to walk on the moon in July of 1969. For the tens of millions of people who watched this event on television it was an unforgettable experience, but the members of my sixth grade space science class were two years old when the Eagle landed. They lack a clear understanding of the greatest scientific achievement of this century.

In the past two years space science phenomena have achieved vast popularity through the mass media. Capturing the minds and imaginations of millions of teenagers, the movies "Star Wars" and "Close Encounters of the Third Kind" have generated a new wave of curiosity for worlds outside our own.

One year ago, while teaching a sixth grade astronomy course, I discovered that my students had an overwhelming interest in space travel. I decided to develop an aerospace program which channeled their interest into the study of science. The greatest obstacle to the program was how to create a learning environment which stimulated the mind and imagination of each child in the classroom. This seemed especially perplexing since 50% of my students were girls and 15% were minorities.

The resulting aerospace curriculum was called Beyond Boundaries. It has been taught as a year-long, sixth grade science course. Students are introduced to the program through discussions and films on the history of space travel. This is followed by a comprehensive discussion of rocket engines and life support systems with special emphasis on the Apollo program.

The study of man in space leads to the central challenge of the course, which is the design of a space ship and the preparation for a twelve year voyage to Alpha Centuri. The class generates a list of the important items which must be considered in the design of the ship, including propulsion, food, medical care, housing and communication. After a brief class discussion on each item, the students are divided into small groups to investigate a specific topic. The communication group, for example, decides that the ship needs radios, telephones, and closed circuit television; then they go to the library and do brief reports on these topics using encyclopedic material so that they can report back to the entire class.

Much of the focus for this three month unit is how to meet the biological needs of man in space. A typical discussion runs as follows:

Mr. Howe: William just mentioned that we are going to need a large quantity of food on this voyage. Do you think that we will be able to store it in cans or a refrigerator?

Rachel: We could probably store enough for a few months, but not twelve years.

Mr. Howe: How will we get enough food?

Derick: I think we should take cows, chickens, and plants so that we can grow our own food.

Melissa: But how will the animals survive without gravity?

Rachel: Maybe we should be vegetarians.

The discussion ends in questions related to food and a homework assignment to investigate the basic nutritional food categories.

After the investigations and discussions are completed, each group prepares an elaborate drawing of its portion of the ship. Proposals are submitted for the exterior design of the vessel and the class chooses the safest and strongest design. Finally, a large cardboard model of the space ship is constructed to hang in the room.

The problem-solving approach to this course enables the teacher to channel the students' curiosity through a wide range of related topics. In keeping with this approach, the next phase of the program begins with the question, where is Alpha Centuri? It soon becomes evident that the class needs to have a solid understanding of the solar system and the constellations in order to reach our destination. This opens two months of study of astronomy. The Universe by Bishop, Lewis and Sutherland (Charles E. Merrill Publishing Company) serves as the text.

Using our solar system as a model, the class investigates the individual planets, paying close attention to the characteristics which are necessary to support life. In further preparation for the voyage, students learn the life cycle of a star with special emphasis on binary star systems like Alpha Centuri. The astronomy unit is also reinforced by evening class with the school's six inch reflector telescope. Glimpses of the moon and stars help students understand the sights they might view from the spaceship.

Mathematics is incorporated into the program through the study of space navigation. Students perform calculations on the amount of fuel needed for the voyage, amount of plant matter needed for air exchange and the direction of flight to arrive at our destination. These problems are encountered in a simplified form so as to further the development of problem solving skills. A sample problem reads as follows:

If our engines use three tons of fuel a month and we plan to have a twelve-year voyage, how many tons of fuel will we need to take with us?

Ten tons of fuel takes up 100 liters of space. Will we have enough room with three 10,000 liter tanks?

The mathematics unit is followed by six weeks of study in the field of geology. Although this unit concentrates on the types of rocks and land

shaping phenomena we find here on earth, parallels are constantly made to our voyage. In order to help the students make the connection between earth geology and inter-stellar space flight, they are asked to try to determine something about the history of a planet if they encountered a certain type of rock on its surface.

On one particular day, when the students arrive in class, they are told that one of the robot ships has descended to the surface of planet B-8 and returned with rock samples. They are asked to examine the samples and write a brief report to transmit back to earth. The reports indicate evidence of some sort of volcanic activity and that there once was some kind of stream or ocean that contained living organisms.

An exercise quite similar to B-8 is used to conclude the course. The students are confronted with photographs, rock samples, orbit information, temperature and atmospheric descriptions for seven imaginary planets in the Alpha Centuri solar system. Based on this information they are asked to write a report and determine which planet(s) might support a colony of humans.

Beyond Boundaries has been taught for one year, and during that time it has successfully met the rigorous criteria for which it was designed. It is a highly motivating program which has been able to capture the interest of girls, boys, and minority students. It is a new and exciting approach to general science, one which can be easily adapted to other schools.

AEROSPACE EDUCATION AT YOUTH DEVELOPMENT CENTER SCHOOL,
WAYNESBURG, PENNSYLVANIA

Edward J. Gluvna
Arts and Crafts Instructor
Youth Development Center School
Waynesburg, Pennsylvania

The Educational Program is through a contract between Intermediate Unit I and the Department of Education in which we conduct an elementary and secondary academic, pre-vocational and vocational school program. The center is in operation during the entire year utilizing the Development Center educational facilities for the school function and community resource center activities. The full-day school program is offered by certified teachers, and geared to the youths' individual levels, as determined by diagnostic testing, interest, and previous school records. All of the students at the center are considered to be socially and emotionally maladjusted. The course of study is designed to aid students who, due to emotional problems, need improvement especially in math and science skills and also in relay theories of industrial education.

Throughout the course we try to describe the tools, materials, processes, occupations and related problems of America's space program through projects including the construction of scale model rockets and spacecraft. It is also desired that after completion of this class students will demonstrate at least some improvement in math and science classes. For example, students will demonstrate the awareness as to how weather factors affect the flight of rockets. Within the area of mathematics the student will be able to demonstrate the use of tangents and computation of altitudes for rocket flight. Some of our students are so limited, so far behind in math that they can't even comprehend fractions. This makes it difficult for them to compute tangents. So we try to use a little slide calculator called a predicted altitude computer. They can use it like a slide rule to calculate model rocket altitudes.

Model rocketry is also valuable to more sophisticated experiments in mathematics, electronics, weather and teamwork. The rocketry program involves 10 students per nine weeks period. So we teach about forty students, sometimes more if possible, over a period of nine months. These are students who usually display an interest in industrial arts and science education.

Originally, the program was conducted as a team teaching project involving me (E. Gluvna) and the science instructor. It also requires the skills of a reading teacher since some of the students cannot read or comprehend even simple instructions. This is one good reason for having mostly pre-assembled kits, especially from Estes Industries in which the instructions are very pictorial in nature. Quite a few of the students that couldn't read the directions were able to successfully complete the kit just by looking at the pictures.

The math instructor also plays an important part in trying to increase their abilities, especially with measurements and computations. Social

science studies include background research of previous real-space flights, astronauts, in fact anything involving aeronautics and space. I think that one particular class did an excellent job of documenting their experience with a presentation. One former student of mine who is presently in the photography program took all the pictures.

The students involved in the projects study the history of rocketry and choose a model rocket which they will build. They are required to write a brief history or outline of a rocket they build, as well as keep a daily log of activities involved in building and operating a rocket. This project is a study of flight as well as the concentration of mathematical formulas needed to ascertain height, distance, pull of gravity and so forth. The study of development rockets, especially in recent years, involves social studies and reading. Reading and use of special terms are also a necessity for successfully building the rockets and keeping records on the progress of their project. I tried to limit the program to forty students per nine month period. We try to select, in cooperation with the guidance counselor, those students who have the highest interest in industrial arts and science. A short pre-test is given to determine their aptitude and initial interest in such a program. I have 6 periods a day of arts and crafts and 1 period of rocketry.

Initially, the rocketry program started about 5 years ago when the principal, during a presentation at the teachers' meeting, said we were looking for new and fresh ideas. He said: "I don't care if they're far fetched or funny or hilarious or whatever." I had done a student center learning activity dealing with rocketry 6 years earlier when I was student teaching. So I submitted an outline to him involving rocket activities, and much to my surprise it went through. Initially, the program cost about \$1,000. Now I get an allotment of about \$800 per year to maintain the program, buy new kits, supplies and textbooks.

During the second year of the program, we had a Cineroc movie camera with which we were able to take super-eight movie film in 50 foot segments from the nose cone of an airborne model rocket. We successfully exposed 4 rolls, the running time of which was 2-3 minutes.

I do have a pre-determined set of objectives which I try to accomplish during the course. 1) The student will select and construct using materials provided, a scale model of a manned or unmanned spacecraft. 2) The student will employ a solid propellant motor in the launching of the model they construct. (These are all pre-made engines packed by Estes Industries.) 3) The student will prepare and present to the instructor, a written description or brief history of each model they construct. For instance, if they were building a model of the German V-2 Rocket, we would naturally require them to go the library, research the German V-2 Rocket, and generate at least a two-page report. 4) The student will determine the height of their model in flight though the use of an altiscope or altitude computer or use of tangents. 5) The student should be able to cite examples of various job opportunities in space technology environment and prepare a written report of at least 2 type-written pages. 6) The student will, through use of various visual aids, demonstrate awareness of educational and vocational information as related to the field of aerospace technology.

Our expected levels of achievement are: 1) the student can construct a scale model of an unmanned spacecraft; 2) the student can use new vocabulary in the writing of a brief history of the model being constructed; 3) they can use properly and safely a commercially prepared solid propellant in the launching of their model; and 4) they can describe at least two educational or vocational experiences, complications or applications of model rocketry in an aerospace environment.

The content of the course is substantially covered in the first four weeks. The text is Space Age Technology by Stanley M. Hajek and Raymond L. Schutte from Estes Industries. The entire course for the first four weeks covers terminology, theory of flight, history of different jets and rockets, power plants, including ramjet, pulse jets, different types of piston engines, rocket propulsion systems, liquid and solid propellants, exhaust nozzles, and guidance controls.

Then we get into the more enjoyable part of the program for most of the students, the actual construction and launchings. Our procedures for evaluation involve written exams, group discussions, visual aids, critique of the individual's written work, critique of their individual model construction, and classroom and field training participation.

QUALITY LEARNING OF ASTRONOMY IN A MULTI-RACIAL SETTING
USING THE BEST FACILITIES AVAILABLE

John Fiszer
Academic Interest Center
Adler Planetarium
Chicago, Illinois

There is something wonderful happening in Chicago. The Chicago Board of Education is assigning teachers to work on location and create exciting programs at many of the great cultural institutions of the city. Similar programs are in operation at the following institutions: Chicago Historical Society, Field Museum, Museum of Science and Industry, Shedd Aquarium, and the Adler Planetarium. These sites are called "Academic Interest Centers" and new centers will be opening in September.

The main goals of all these programs are excellence in education and voluntary racial and ethnic integration. These programs are a part of the Chicago Board of Education's "Access to Excellence" program, which is the nation's largest voluntary student desegregation program.

Each Academic Interest Center (AIC) is staffed by two Board of Education teachers: a Field Service Representative and a Center Teacher Coordinator. Participation in the program is voluntary, and any Chicago Public School may apply to take part. Two classes from two different schools--one minority and the other majority--with children approximately at the same ability level, participate at the same time. Children spend three days at the Planetarium, usually Tuesday through Thursday, from 10:00 a.m. to 1:15 p.m. Transportation for children is provided by the program. The participants are selected by the staffs of each Academic Interest Center.

The Adler Planetarium Academic Interest Center program consists of four parts. After the selection of schools in accordance with the guidelines, teachers and parents attend a one-day, in-service workshop at the Planetarium, two to four weeks prior to the program. The classroom teacher and two to three parents from each participating school attend the workshop. The workshop familiarizes them with their instructional role and the program's subject matter. Their roles are to be co-educators and additional resource persons for the students. After a welcome and introductions, the teachers and parents are taken to the Sky Theatre. Here they are shown how to use "Star Finder Dials" with the aid of the Planetarium's star projector. I cannot think of any better way of teaching recognition of the constellations.

Following the brief introduction to the constellations, the teachers and parents are treated to the Sky Show, which the children will see on the third day of their program. After the show, the workshop participants make their own "Star Finder Dials," as well as "Phases of the Moon Dials." Then each teacher is given enough material for every student to make their own dials before coming to the Planetarium.

After lunch the participants are taken to the exhibits, where they can work through the same activity sheets that their students will be using.

Later they are introduced to small telescopes of different kinds and to the large telescope at the Planetarium's Doane Observatory. Finally the teachers are given audio-cassette tapes of mythological stories and songs, a vocabulary list, and a list of concepts--all to be introduced to their students prior to the program.

About two weeks before the children come to the Planetarium, the Field Service Representative visits the classrooms of the two teachers. There he introduces the children to the program through the use of slides, makes sure that the pupils understand most of the basic vocabulary and concepts, and may play a record or tape of space songs or myth stories.

The buses arrive at the Planetarium, and the first day of the children's program begins. The two classes are divided into four activity groups. Pre-grouping has been done at the home schools. At the Planetarium we join Group 1 of school A with Group 1 of school B, etc. The children stay in these same groups as they work on activities, eat lunch, and attend the daily Sky Theatre lecture-demonstration during all three days of the program.

Soon after arrival, the children are taken to the Milky Way Theatre where they are welcomed, introduced to all the teachers and parents, and reminded of the few rules they are asked to follow. The activity groups of sixteen are then divided into teams of four--two from one school and two from the other school. This, of course, allows the children to meet and work with pupils from the other school, and makes it easier for the children to do the prepared activities.

With activity sheets on slipboards, the children go to a variety of exhibits designed to explain the Solar System and the larger Universe. In the Hall of Space Exploration for example, they gather facts and concepts about our sun's family. The information the students gather is quite current, since the exhibits are continuously updated by the Planetarium staff. Many teachers are surprised to find more moons around Jupiter than they had known of before, and to find planets with ring systems that are not shown in their latest textbooks.

After lunch the children are taken to the Sky Theatre where the planetary motions, solar and lunar eclipses, and the changing noontime position of the sun throughout the year are realistically demonstrated.

The second day of the program is spent on the study of telescopes. The pupils are divided into three groups instead of the usual four groups. One group uses small telescopes, the other tours the Doane Observatory, and the third group studies telescopes of various kinds inside the Planetarium using an activity sheet as a guide.

After lunch the children learn about constellations in the Sky Theatre. Working in groups of two, the children study the constellations using classroom-constructed Star Finder Dials, red-light flashlights, and the projected stars on the domed screen of the Sky Theatre. With the aid of the artificial night sky and the projected constellation outlines, the pupils quickly learn to associate groupings of stars as belonging to particular constellations and to visualize the constellations as figures of famous heroes, kings, queens, and animals of mythology.

On the third day the students join other school groups to attend the two-part school Sky Show produced by the Planetarium staff. Each sky show is new and different for each season and year. This experience is a special highlight and climax of the three-day program.

After lunch, the children are divided into two groups, led by the two AIC teachers, to discuss the three-day program. At this time, the AIC staff tries to give added depth and breadth to the program, emphasizing the students' awareness of being part of a larger Universe.

While the program is being reviewed by the pupils and the AIC staff, the teachers and parents complete an evaluation form. At this time they have the opportunity to suggest improvements or raise objections to parts of the program. Our program continually is undergoing revisions to make it more enjoyable and educational for the children.

At the end of the three-day program, group pictures are usually taken. Children leave and while on the bus, enjoy Chicago's beautiful lake-front. Hopefully, the children will come back often to see and learn at the Planetarium, together with their families.

Within a week after the on-site program, the Field Service Teacher provides the last part of the program--the post-service. At this time, questions are answered, completed activities further discussed, space songs sung, and demonstrations of difficult concepts presented.

The Field Service Teacher then suggests projects for further study by the class or individuals. Follow-up visits to the school by the Field Service Teacher are determined by the need of the class as the students develop their future projects. As an example of a post-service project, the children have constructed the Solar System, to the scale of 1 inch = 1,000 miles. They were surprised to see the great differences in size of the planets and the distances between them.

What Have Been the Results of the Program?

Judging from the responses--both verbal and written--most of the teachers and parents who participated consider the program a great success and hope to take part in it again. Allow me to quote some of their comments taken from the evaluation forms:

QUESTION: Did the program arouse the interest and curiosity of your students?

"Oh, yes! We'll be involved in space drama for months. I already have enlisted the Burns School Art Teacher to help us create a huge mural. Another teacher in the school who has a pilot's license is going to work on a project with us. We'll probably make a class exhibit for the science fair."

"It changed careers of some students and motivated others to do research."

"A tremendous experience--Thank you for your hard work and for inviting us."

"It caught the attention of some students who otherwise could care less."

"My own son was very excited and eager for the next day."

Response from a teacher of the hearing-impaired:

"Yes, the class was especially interested in the Sky Theater and all the "manipulative" exercises. The children need as much visual instruction as possible so any learning activity that is supplemented by a visual demonstration that allows child participation is very beneficial. The class was anxious to come and enthusiastic at each session. The material presented at the Planetarium could not be duplicated as effectively in the classroom."

Letters from students:

"How are you? I am glad that our class got picked for the Planetarium. I learned so many things. I am going to bed early Friday so I can wake up early Saturday and see the sun rise. I am going to wake up my mom so she can see the planets Venus and Mars. I learned so much my sister gets jealous when I pick out the stars. I liked the sky theater but I can't explain it to my mom. Well, I have to go now." -Tina Curtis

"I really enjoyed coming to the Planetarium. It was a sight to see. I learned a lot about the constellations and the solar system. I didn't learn much about my sign. I am a Scorpio. I did learn about the constellations. You taught us a lot with the little time we had. In the beginning I didn't have much interest in the solar system because I thought of it as a group of stars and a moon but now I understand how important they really are. Thursday night about 8:10 I was in the park watching the moon and the stars and I found out that if you really stare for a long time you can really see a face. I didn't see many stars but I did see about two or three of them. What I am really trying to say is thanks for the good times you have given me." -Vickie Willis

The reasons for teacher and parent satisfaction with the program are easy to see. Children are exposed to something that is unavailable in their schools, that is, the unique equipment of the Planetarium and particular expertise of its staff and that of the AIC. It provides exciting learning experiences that increase or build upon students' interests. These results are very encouraging. Students arrive at the program excited and leave highly motivated and eager for more learning and independent research. This urge for more learning is proven by their post-service projects.

In conclusion, we find the AIC program to be truly a unique educational experience--bringing together access to educational excellence with a

natural and congenial inter-action of children of various racial and ethnic backgrounds. We feel that this approach is especially helpful because it takes place in a community cultural institution, which can be perceived as "neutral ground" amid the many polarities within the community. We hope that the success of the program in Chicago--which will include over a dozen institutions by this September--will encourage other communities to experiment with similar programs, adapted to their needs.

AMERICAN VALUES AND AVIATION, 1900-1950

David K. Vaughn
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Overview

The subject of this presentation is the philosophy, rationale, and administration of a humanities-oriented aerospace education course which examines traditional American values and beliefs as reflected in the writings about American aviators and aviation from the turn of the century to the end of World War II. The unifying thematic thread of the course is the development of an awareness and understanding of characteristic American values and attitudes as they are discovered and examined in the works of well-known aviators and writers, including Eddie Rickenbacker, Charles and Anne Morrow Lindbergh, Amelia Earhart, "Pappy" Boyington, James Gould Cozzens, John Hersey, and William Faulkner, among others. The course also recognizes the struggles and achievements of women and blacks in aviation by placing their efforts against the background of the technical and cultural development of aviation.

This course is designed to be offered through any continuing education center, be it school, library, college, or museum. It is primarily designed as an adult education course, although young people in the 10th grade and up could also participate successfully. The course runs for a period of from four to eight months, depending on the length and number of class sessions. Ideally, eight class meetings are devoted to detailed two-hour discussions of the works listed. Class discussions can be led by specifically-designated individuals or by volunteer discussion leaders. The course can easily be shortened or lengthened according to student interest and availability of texts. Course readings have been determined primarily by text availability and price; however, some texts may not be readily available. If presented in a museum or library setting, the course content can be supplemented with appropriate pictorial displays.

Course Rationale

In contrast to most aerospace education courses, which are usually oriented towards technical or scientific subjects, this course develops aerospace education topics in humanities-related subjects. Although most aerospace education courses devote numerous hours of instruction to the analysis of how scientific principles and technological know-how will help to launch men and women into the air and space, few devote time to considering why the act of flying is so challenging and exciting, or to considering the relationship between flight and the beliefs and myths that constitute our cultural heritage or to analyzing the complex moral and ethical issues associated with the development of air and space power. The importance of the humanitarian disciplines in the field of aerospace education becomes evident immediately when one appreciates the fact that few actions can match the phenomenon of flight for both its emotional excitement and physical danger. The aspects of benevolence and malevolence associated with the machines of flight are awesome.

Yet the possibilities of their powers cannot be ignored, for the power to do good or ill does not lie in the machines themselves, but in the human hands that guide them.

This idea is effectively stated by Charles Lindbergh; writing his Spirit of St. Louis after the end of the war, and meditating on the future, he observes that "unlike the early years of aviation, our dreams of tomorrow are disturbed by the realities of today. In this new, almost superhuman world, we find alarming imperfections. We have seen the aircraft, to which we devoted our lives, destroying the civilization that created them. We realize that the very efficiency of our machines threatens the character of the men who build and operate them."

The range of possibilities for the helpful or harmful use of air and space power is as comprehensive as the human spirit itself. While we can read of the extremes of the human spirit in our daily paper, it is particularly appropriate to familiarize ourselves with the thoughts and experiences of others associated with aviation activities in the past, to see what ideas or emotional pressures prompted them to respond to their experiences in the way that they did, and to see how human attitudes and perspectives are modified by the aircraft environment. And while we can rest comfortably knowing that no individual in the American experience has thus far gloried in the misuse of airpower, the course readings will provide ample opportunity to observe a full range of anger, sorrow, fear, and exhilaration demonstrated in the experiences of these individuals. So as we read of the achievements of these individuals, we will find that we are rediscovering the traditional American values and a changing American attitude towards those values. And by re-examining these values as they have been articulated by our aviation pioneers, we may be able to place the foundations of our own philosophies on the observations and experiences of those who have gone before us.

American Character and American Aviation

As we read each of the works in the course, we will find attitudes and beliefs that largely define American aviators and the American culture which nurtured them. The main ingredients of the American character include these principal items:

- ° a rise from a middle-class or lower-middle-class background
- ° a sense of independence and self-reliance
- ° a belief in optimism and idealism
- ° a belief in the possibility of achieving professional and financial recognition
- ° a belief in the advantages of and necessity for technological progress
- ° a belief in the American system of hard work and fair play
- ° a belief in a benevolent deity

Keeping these ideas in mind, we will now examine the primary course works, as listed in the attached model syllabus and selected bibliography, to identify their unique aspects and common characteristics.

One individual who demonstrates all of these beliefs and whose life spans the entire period is Eddie Rickenbacker, World War I ace, racing car driver, airline president, ambassador-at-large, survivor of numerous accidents. His personable and informally-written autobiography, Rickenbacker, serves as the perfect work to open the course, for it describes the life of a man fully active in the main aviation developments from World War I through the post-World War II period; the history of the man could fairly be said to be the history of American aviation. Rickenbacker's unabashed love of country, his belief in God and in the American principles of freedom, his optimistic outlook, his unflagging energy, his unbelievably good luck, and his phenomenal personal success combine to make him the archetype of the model American aviator, and the story of his life provides the touchstone to a survey of the era.

Following the course overview provided by Rickenbacker's life story, the next step is to consider the achievements of the founders of American aviation, the Wright Brothers. Unfortunately, there is no good biography of Orville and Wilbur Wright. The standard biography is Fred C. Kelly's The Wright Brothers. A good alternate study is a recent publication of the Smithsonian Institution, The Wright Brothers: Heirs of Prometheus, edited by Richard P. Hallion. This volume contains informative essays on the achievements and influences of the Wrights. They established the pattern for successful aviation endeavors through their meticulous attention to detail and thorough experimentation. They were certainly self-reliant and independent; like Rickenbacker, they believed in what they were doing. Like Rickenbacker, they came from a middle-class background and attained recognition in their field through hard work.

World War I provided aviation with the necessary technical impetus and helped to advance aircraft performance and design immeasurably, but the proportion of written commentary to flying activity during this period falls far short of that of later conflicts. Perhaps the reason was the brevity of the American involvement in aerial combat, or the lack of awareness that the subject could contain material worthy of written description. The principal works of the period are the writings of Nordhoff and Hall. Their Falcons of France, published in 1929, is essentially a battle memoir, written by two men who were themselves pilots in the Lafayette Escadrille.

One important American writer to be intrigued by the subject of flight as a topic of serious literary endeavor was William Faulkner. His flight-related narratives are among his most sophisticated and stylistically intricate works. Faulkner wanted to fly for the Allies in World War I and apparently began flight training in Canada. However, his military and flying career was short-lived, and even today the extent of his actual flying experience during that period is not clearly known. Faulkner wrote six short stories and two novels about pilots or pilots' responses to the experiences of flying. Two of his short stories deal particularly with World War I: "Ad Astra" and "Turnabout." "Ad Astra" describes an evening party attended by Allied pilots of various nationalities -- American, British, Irish, a captured German pilot, and an Indian subahdar. These international combatants reveal, in the course of the evening's festivities, that they all hold generally disillusioned attitudes

towards the war. "Turnabout" describes the reaction of an American aviator who gives a British sailor a ride in his aircraft during a bombing mission and then accepts a ride in the sailor's patrol boat in return, discovering that the sailor's combat risks are as great, if not greater, than those involved in flying.

Faulkner's primary aviation-related novel, Pylon, offers an intense and personal vision of the experiences of those who fly. Pylon describes the events of an air show at a New Orleans airport in the early 1930's. The narrative focuses on the activities of a flying team consisting of two pilots, a mechanic, a woman and a child, and on a reporter from a local newspaper, who is fascinated by the flying crew's life style. The novel ends with the death of one of the pilots during an air race around fixed pylons, and the reporter finds that although his search for the motivating forces of the team has been unavailing, both his frustration and admiration have increased. Pylon is a difficult and sometimes obscure book to read, and it is filled with complex symbols -- such as the pylons themselves -- and numerous references and allusions to other literary works, including T.S. Eliot's long poem, "The Wasteland."

The key aviator of the first half of the twentieth century is Charles Lindbergh, and the document that illuminates the quality of his mind as well as the events of his historic flight across the Atlantic in 1927 is The Spirit of St. Louis. Although he had written a book about that flight shortly after it occurred, entitled We, he was not satisfied with its quality or content, and he began work on a totally new account of the flight in the 1930's. However, World War II intervened, and he was not able to complete this revised version until 1953. The public was rewarded for the delay, for The Spirit of St. Louis effectively combines technical detail, historical background and personal philosophy. The book reveals a man who also, like the Wrights and Eddie Rickenbacker came from a modest background and who found personal fulfillment through hard work and perseverance, and whose spirit remained optimistic, even if his outlook in later life became more cautious. Lindbergh's mind was consistently of a careful, rational bent, and these qualities are fully illustrated in the book. The Spirit of St. Louis should serve to show that Lindbergh's flight across the Atlantic was not the result of a spontaneous, spur-of-the-moment decision. The flight was carefully planned from start to finish with the same technical precision and experimentally derived approach to data-gathering the Wright brothers displayed nearly twenty-five years earlier. But perhaps the greatest challenge Lindbergh faced during the flight, and this is clearly shown in the book was his struggle against himself, the struggle to extend the limits of human endurance, to survive the physical as well as mechanical challenge of the flight.

Equally well-known, although perhaps more for literary than piloting skills, is Anne Morrow Lindbergh, whose flight-related writings have provided educational and motivational experiences for all readers, especially for women. Such classics as Listen! The Wind and North to the Orient, which describe the Lindbergh's flights across the Pacific and Atlantic, were praised from the time they first appeared in the 1930's. Her poems have been widely acclaimed. Gift From the Sea continues to inspire women and the women's movement today, over twenty years after it was first written, and so does the on-going publication of her diaries and letters. Her ability to see the forces of society represented in such common objects as sea shells or tea

gardens is nowhere better displayed than in North to the Orient, a highly personal yet culturally broad perspective of their flight across Canada and Alaska to Japan and China.

If Anne Morrow Lindbergh's background stands an exception to the criteria of the American character described earlier, we have the satisfaction of knowing that her East Coast heritage and her upper class training helped her to become the most literate of all aviation writers. But two other women of the period--Amelia Earhart and Jacqueline Cochran--definitely illustrate the criteria of the American character. Amelia Earhart came from a middle-class background, from Kansas, and like Dorothy in L. Frank Baum's The Wizard of Oz, she made her escape via the air. Amelia's wizard was George Palmer Putnam, a New York publisher, who encouraged her to seek her freedom through her aviation endeavors. And although she was credited as the first woman to fly the Atlantic, she knew she had been merely a passenger on that flight, and she wanted to establish her aviation credentials on her own merit. Last Flight is the uncompleted record of her final attempt to achieve that flying fame. Although her effort failed as she disappeared on a flight from Lae, New Guinea, to Howland Island, on 2 July 1937, she deserves a position of high regard today, not only for her flying achievements, but also for her exhortations to women to "try to do things as men have tried."

Jacqueline Cochran may be less well-known than Anne Morrow Lindbergh or Amelia Earhart, but the list of her flying accomplishments after she earned her pilot's license in 1932 contains numerous significant items: winner of over two hundred awards and trophies; recipient of the Billy Mitchell award in 1937; first woman to fly faster than the speed of sound; and Director of the Women's Air Service Pilots (WASPs). Her biography, The Stars at Noon, tells the informal but fascinating story of her life. Raised in a "poor white" existence in the deep South, lacking shoes until she was eight, she worked with single-minded determination to achieve success, and by the time of World War II was a highly-valued leader in civil aviation.

While women were attaining some degree of individual and collective success in establishing their impact in the field of aviation, another minority group was not. Black Americans found their access to recognition and acceptance in the field of aviation blocked by traditional white attitudes of suspicion and distrust, and by feelings of doubt about the blacks' ability to fly in combat and to maintain their aircraft in a combat environment. The story of black aviation is largely the story of the Tuskegee Institute in Alabama and of the black pilot training program conducted there before and during World War II. The success of that training program is shown in the respectable combat record of the 99th Pursuit Squadron, which flew in the Mediterranean theater.

Although the story of the black experience in World War II has been described by two members of the faculty of the Air Force Academy's History Department, Alan Gropman and Alan Osur, one of the first works to address the problem of the white refusal to accept blacks in aviation was James Gould Cozzens' Pulitzer prizewinning novel, Guard of Honor.

Guard of Honor is set at a Florida Air Base and focuses on the efforts of a few key base officials to deal acceptably and humanely with the problems

created when a group of black officers rejects the separate but equal discriminatory practices then followed by the Army Air Forces. Two incidents provide the primary issues of the novel; in one, an angry white officer strikes a young black pilot for contributing to a near-miss aircraft incident; in the other, a group of black officers is arrested for protesting at the "off-limits" white officers club by seeking service there.

The story is told from the white perspective throughout, and does not accurately convey the black experience. However, it does hint repeatedly at the main ingredients of black discomfort, and one of its episodes--the invasion of the off-limit club--is based on a true incident that occurred during the war at an Army Air Base in Indiana.

With the onset of World War II, flying activity increased significantly and writing about flying proliferated. One of the primary kinds of written document the war produced was the "battle memoir"; two of these serve as models for the course, Robert L. Scott's God Is My Co-Pilot, and Gregory "Pappy" Boyington's Baa Baa Black Sheep. Scott's God Is My Co-Pilot was one of the first written, in 1943, and describes his activities flying P-40's in General Chennault's American Volunteer Group against the Japanese in the China-Burma-India theater. It is full of anti-Japanese sentiment, understandable at the time but embarrassing today. Yet if it is read as it was intended, as an energetic and patriotic outburst against an enemy that at that time held the upper hand in battle, its anger can be understood. Scott tells in graphic and exciting detail of his success in flying his P-40, "Old Exterminator," against overwhelming numbers of Japanese aircraft. The energy of his narrative is indicative of the high level of his anger towards the Japanese; although the word "God" appears in the title of his book, the word "hate" appears much more often in its pages.

"Pappy" Boyington's Baa Baa Black Sheep was one of the last WWII battle memoirs to be written; Boyington completed it in 1956, after he had survived a severe bout with alcoholism in his adjustment to the end of the war. The later date of composition places a different perspective on Boyington's narrative, for instead of Scott's attitude of belligerent daring, Boyington looks back on his activities in the Pacific, flying P-40's in the China-Burma-India theater, and later flying Corsairs in the South Pacific, with the moderation gained from the disillusionment of his post-war experience. And although the energy of the battle episodes is evident, it is tempered by the narrator's awareness of subsequent events. As a result, the emphasis on survival--in the Japanese camps and in the post-war world--matches that of the thrill of aerial combat. The pre-war innocence of Scott is balanced by the post-war tentativeness of Boyington, and their change in vision is instructive for what it tells us about the shift in American values as a result of the war.

The erosion of confidence in progress, in technology, in the "American Way," is evident in the last work included in the course, John Hersey's The War Lover, a novel which describes a B-17 crew's ill-fated bombing mission over Germany. The story focuses on the conflict between "Buzz" Marrow, the hot-headed aircraft commander, and Charles Boman, the co-pilot. The bombing mission provides the structural framework of the novel, as sequences of the mission are interrupted by flashback episodes of the crew's six-month stay in England. Marrow's philosophy of war and life are the same: aggressive

and thrill-seeking, but Boman, younger and more inexperienced, believes in caution and consideration. They share an interest in an English girl, Daphne, and Marrow seems to control events until his airplane falls victim to German aircraft and flak attacks. As the plane's systems begin to fail one by one, Marrow becomes immobilized, and Boman takes command of the aircraft, skillfully flying it to a successful ditching in the English Channel. The crew is saved, except for Marrow, who clings to the rapidly sinking airplane, like Ahab to his whale. The novel is clearly anti-war in its theme and execution, and the misguided principles personified in the pilot, Marrow, and his aircraft, "The Body", are obviously meant to warn us against too great a delight in the technological power of our warmaking machines. The War Lover examines many of our traditional American values, as illustrated by both Marrow and Boman, and asks us to assess their potential for danger as well as benefit.

Through autobiographies, battle reminiscences, and fictional works, this course can offer an informative and unusual route to the simultaneous discovery of American ideas and attitudes and of the past achievements of the American aviation effort. The course covers a broad range of subjects, and results from arbitrary limitations, for its focus could easily have been turned in a number of different directions. It could, for instance, have limited itself exclusively to a study of women in aviation, to an examination of the difficulties associated with integrating black Americans into the Army Air Forces, to an analysis of the air battles of World War I or II, to the rise of civil aviation, or to the intricacies of literature about flight. Obviously, any of these topics could provide the basis for an informative and enjoyable course of study. However, the course as it is structured presents a historical survey which offers a good introduction to each of these subjects and should serve to promote further individual explorations of these areas.

American Values and American Aviation, 1900-1950

Model Syllabus

Lesson 1: Introduction and Overview of Period, 1900-1950

Primary reading: Eddie Rickenbacker, Rickenbacker

Supplementary readings: Robert and Briand, The Sound of Wings
Rodman, Poetry of Wings

Lesson 2: The First Flyers: The Wrights and WWI

Primary readings: Kelly, The Wright Brothers
Hallion (ed.), The Wright Brothers:
Heirs to Prometheus

Supplementary readings: Nordhoff and Hall, Falcons of France
Hall and Nordhoff, The Lafayette Flying Corps
Rickenbacker, Fighting the Flying Circus
Nordhoff, The Fledgling

Lesson 3: Literary Interpretation of Flight: Faulkner and the Moral
Price of Flight

Primary readings: Faulkner, "Ad Astra," "Turnabout," in
Collected Stories
Faulkner, Pylon

Lesson 4: Charles Lindbergh: "The Last Hero"

Primary readings: Charles Lindbergh, The Spirit of St. Louis
Charles Lindbergh, The Wartime Journals

Supplementary readings: Charles Lindbergh, Of Flight and Life
Charles Lindbergh, Autobiography of Values
Crouch, Charles A. Lindbergh: An American Life

Lesson 5: Women Pioneers in Aviation

Primary readings: Anne Morrow Lindbergh, North to the Orient
Amelia Earhart, Last Flight
Jacqueline Cochran, The Stars at Noon

Supplementary readings: Amelia Earhart, The Fun of It
Anne Morrow Lindbergh, Gift From the Sea
Anne Morrow Lindbergh, Listen! The Wind
Anne Morrow Lindbergh, Diaries and Letters
Oakes, U.S. Women in Aviation Through WWI

Lesson 6: Black Americans in the Army Air Forces

Primary readings: Cozzens, Guard of Honor

Supplementary readings: Gropman, The Air Force Integrates, 1945-1964
Osur, Blacks in the AAF During WWII
Francis, The Tuskegee Airmen

Lesson 7: World War II: Battle Narratives

Primary readings: Scott, God Is My Co-Pilot
Boyington, Baa Baa Black Sheep

Lesson 8: World War II: The War Novel

Primary readings: Hersey, The War Lover

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THE HEAVENS AND SPACE: COMMON HERITAGE AND FUTURE FOR ALL CULTURES

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Astronomy offers unique advantages to educators with multi-cultural goals. By looking at astronomy from the perspectives of various cultures, it may be possible to shake up some of the pre-existing notions about science in different cultures and thereby stimulate the creation of new and innovative methods of science education.

The most widely shared environmental influence on different human cultures is the heavens. Only the facts of human biology such as birth, growth, aging, and death provide as universal an influence on people throughout the world. Though universal, these biological influences are not as constant, predictable or unchanging as the heavens. Nor are geographical or climatological environments, as can be witnessed by the differences between the jungles of the Amazons, the mountains of Tibet, and the deserts of our own Southwest.

But for people at the same latitude, the patterns and rhythms of the heavens are absolutely identical around the earth. This means, for example, that the people of Borneo, Ecuador, and Kenya see the same patterns of stars and planets on the same day.

For cultures at different latitudes, the heavens appear only slightly different. The same patterns, or constellations of stars, can be seen over wide ranges of latitude. The seven stars of the "Big Dipper," for example, can be seen all the way from the North Pole to as far south as northern Australia. The cyclic motions of the sun, moon, and planets are experienced alike by cultures worldwide.

These commonalities between all cultures can best be demonstrated by shattering two commonly held prejudices: first, that "primitive" cultures lack(ed) rational thought; second, that "advanced" cultures lack irrational thought. By examining how people understood the heavens and understand space, it is easy to show that these two prejudices are unfounded.

"Primitive" peoples are often depicted as being irrationally fearful of celestial events and as believing in absurd concepts of the universe. Misapplied Darwinism may be the reason behind the belief that "primitive" cultures are less evolved and therefore stupider than "advanced" cultures. In the last decade a new interdisciplinary science called archaeoastronomy has begun to dispel these notions.

"Primitive" peoples were certainly more aware of the rhythms and cycles in the heavens than are modern people. They had to be. Calendars were necessary to keep fragile hunting and gathering, and agricultural societies alive. The ability to predict celestial events is also important for the survival of the religious and magical systems of "primitive" people. Whereas contemporary western people live in an intricate and complex "spatially"

oriented universe befitting the heritage of Copernicus, primitive peoples lived in a highly rational and complex "temporally" oriented universe, alive with the cycles of the heavens.

Physical evidence of the rationality of "primitive" peoples can be found worldwide. Native Americans built wheels of piles of stones called Medicine Wheels, that were used to observe the rising points of stars to mark the coming of the different seasons.

In south-central Kenya, archaeoastronomers have discovered and analyzed a pattern of 19 stones constructed in 300 B.C. These stones have the same function of the Native American Medicine Wheels. They help establish calendars by serving like rifle sights to watch certain stars and constellations rise.

Archaeologists have shown that Babylonian astronomers left meticulous and careful records of observations of the heavens (particularly Venus) that are as old as 3,000 B.C. Just recently archaeoastronomers, studying ruins at Chichen Itza in the Yucatan, have demonstrated that the Maya observed Venus and recorded its motions so carefully that they were able to construct a Venus calendar that was accurate enough to be off by only half an hour in one century!

The most famous archaeoastronomical site is Stonehenge in England. Portions date to as early as 2,800 B.C. and reveal the intricacies of what was a lunar and solar observatory. Some have even speculated that Stonehenge is accurate enough to have predicted solar eclipses.

Even a casual introduction to archaeoastronomy reveals how culturally independent and sophisticated astronomical knowledge was. Given the constraints of available materials, geography, and the level of technology, widely different cultures had consistently similar empirical knowledge of the heavens. Archaeoastronomy is still in its infancy. Many new discoveries in the future will no doubt reinforce the notion that diverse ancient cultures were indeed more commonly rational than was at first believed.

But what about the present western culture? Is it so rational as people would believe it is? Do all people perceive the heavens and space with the same passionless reason of the astronomer?

To anyone who stops and reflects for a moment, the answers to all of these questions are clearly, "No." Modern irrational and mythical heroes such as Superman are still vital forces in our culture. People want most to believe in something, not just learn the facts. Understanding this mythical need can be useful to science educators seeking to motivate their students.

Astronomy and space studies are full of mythical contents. A few common myths that can be found running throughout peoples attraction to space are: flight into the heavens, escape from earth's bounds to future utopias, death and rebirth, and origin myths.

For example, the mythical desire to fly off the earth to a heavenly utopia is as alive today as it was for the Persians who told the myth of Kai-Kuk conquering flight by training four eagles to lift his throne, or for the

16th century Orland Furioso and his four-horse carriage that flew him to the moon. Today our carriage is real; it is the Space Shuttle. But our conceptions of future orbital civilizations are utopian--with their vast and beautiful environments, and the promises that they will cure the ills of the world.

Experience with students studying the most exotic of all scientific creatures--the black hole--has revealed irrational, mythical motivations. Are black holes the latest metaphor for death? The intense attraction of students to the possibility of falling into a black hole, only to wind up in another universe, is as intense as the attraction of rebirth after death found in most cultures.

The multicultural perspectives into the rational past and the irrational present should be useful to science educators. By spreading the results of archaeoastronomy, the rational dignity of the so-called "primitive" cultures can be promoted. Utilizing the rational knowledge of the ancients in science education for children may also be directly valuable in light of the suggestion of Piaget that it is advisable to "...repeat in his life span the process involved historically in the genesis of scientific thought."

Consideration of the overly neglected, at least in science education, irrational and mythical needs of adults as well as children can also help provide strong motivating forces. Because of the commonality between past and present sky myths of most cultures, myths from different cultures can help to satisfy these mythical needs.

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MYTEAM LEARNBALL

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My first five years of teaching seventh and eighth grade math were somewhat discouraging. Many of my students had not learned the basic building-block kinds of skills in the lower grades and had a lot of trouble performing even the most simple tasks. Most of them could not read and write whole numbers, much less fractions or decimals. Listening skills were also poorly developed in a majority of the learners, and many created discipline disruptions that disturbed the classroom setting. The students who had well developed abilities dragged their feet in the discouraging atmosphere and often seemed bored.

In searching for ways to deal with these problems, I switched from traditional techniques to semi-individualized group work to totally individualized instruction. Even though my materials were carefully developed to help each student at his/her own level, the students who had experienced failure throughout their school years were not motivated to do their best. It was common in the individualized instruction program for me to start a student on a lesson, make my rounds helping others get started, and return to the first student 15 or 20 minutes later only to find the work exactly where it was when I left earlier. It was apparent to me that I couldn't reinforce the learning and keep students working because there just wasn't enough of me to go around. The idea of receiving a grade on a report card at some distant future time was far from enough reinforcement for most, and a minimum passing grade was often good enough. Efforts such as pass/fail grading and progress reports instead of grades produced spotty results at best. It seemed nothing I tried could sustain a long hard drive in the classroom.

Then, my advisor at the university introduced me to LEARNBALL. I obtained a LEARNBALL kit and read the instructions. From the very first moment I walked into my room with the LEARNBALL scoreboard, my students' attitude and behavior began to improve. Following the LEARNBALL instructions we placed the scoreboard in the proper position, and I demonstrated throwing the little foam ball and moving the score markers. I also explained how LEARNBALL would create a "team spirit" atmosphere for learning. My students voted unanimously to give it a try. We formed two teams, elected a leader, coach, secretary, and scorekeeper and also selected a distinctive team name for each team. Students agreed to abide by LEARNBALL rules which simply meant that obeying the regular rules I already had established now earned points toward a team score. From that point six years ago, LEARNBALL teams in my classroom have made good work and good conduct the basis for a lively contest every day.

I will describe my classroom operation here, but please understand that LEARNBALL is only a way to organize a classroom. The way I teach the materials and the way you teach must be viewed separately from the LEARNBALL format. LEARNBALL supports my own teaching style by giving a team score reward for the desired student activity. You undoubtedly will

use a different approach, but the LEARNBALL scoreboard can reinforce student actions with whatever teaching method you wish to use.

A typical LEARNBALL class begins as soon as the dismissal bell rings for the previous class. A few students usually hurry in even before all the prior class members have departed. Team secretaries or duly authorized representatives quickly pass out all the corrected assignments from the previous day and place them on the various student desks. Scorekeepers scurry to return the markers to zero on the scoreboard, so the new game can begin. Coaches remind teammates, "Hurry! Turn in your assignment before the bell rings or we won't get the points."

A team leader can be heard saying things like, "Where's your book, Chuck? Okay, good, but where's the cover? Have Susie help you cover it! I'm not giving the Aces any more points just because you don't have a cover on your book." "Tom, here's a pencil you can borrow, but make sure I get it back after class." "Hurry up! Sit down so we'll be first in position."

As the bell rings, all activity comes to an abrupt halt as students slide quickly into their seats. All talking stops as I move to the center of the room and call, "Showdown, pencils!" Fourteen hands holding pencils fly up on the Ace's side of the room. They are quickly counted, and fourteen points are awarded to the Aces and scored on the scoreboard by the scorekeeper. Twelve pencils shoot up on the Raider's team and twelve points are scored on the board, while the leader says, "Aw, Tom, I told you to get a pencil. Now you cost us a point." Next I call, "Showdown, books with covers!" Both teams lift books in the air for a quick count and scoring of points. "Showdown, assignments," is next and teammates who turned in their work before the bell raise their hands. The points are scored for each team and recorded on the scoreboard by the scorekeeper. This whole procedure takes about 2 minutes.

At the end of the showdown, there are varied techniques that can be used to get the lesson across -- lecture at the board, work day in class, group work within the teams, or one point contests on material presented the previous day. Whatever the activity, the teams compete on behavior. For example, if Johnny on the Aces team begins talking to his buddy during a lecture or board work, I say, "Stealing," (because Johnny is stealing valuable time by interrupting class), and points are quickly given to the other team.

During class, if materials need to be passed out, the team secretaries do that. If students have questions during work sessions, the coaches will help by answering questions and explaining the material. This allows me to concentrate on the more difficult learning problems and gives me the time I need to really help a slow learner. Often students who would be embarrassed to ask me a question because I am the person who gives the grade, will readily ask a coach who is close in age and not in an evaluative position. The coach can help students with most questions and has no qualms about asking for my help when more difficult problems arise. All during class, leaders keep an eye on the behavior of their teams in an effort to maintain good teamwork habits and proper conduct so that as few points as possible will be awarded to the opposing team.

The various student roles are a great source of help to the teacher and give the students valuable experience too. The extra hands allow the teacher time to step back and study what is going on, to see who needs help, and to talk individually with those students.

A few minutes before class ends, "Clean-up" is called. Within two minutes all materials are put away, students are in their properly arranged seats, and team areas are neat with no papers on the floor or on desks. The Aces finish first and are awarded 5 points. The Aces are now ahead of the Raiders by 5 points on the scoreboard. The Aces' leader elects to have the Aces take the first shot with the ball. An Ace team member tries a 10 point shot. The foam ball swishes through the net and the applause breaks the silence. A Raider steps up, and shoots from the 15 point position and ties the game as his teammates smile and clap. Back and forth the score goes as the two teams alternate shots. The bell rings. The Raiders take the final shot for 20 points and move ahead of the Aces by 10 points. Wild applause rings out from the Raiders team, then immediate silence. The winners are dismissed first. As they proudly leave the room, members of the Tigers and the Angels from my next class are pouring into the room to begin their contest.

This procedure is followed daily with variations as needed for tests, reviews, etc., except that on Friday I stage a really big question and answer session that forms a dramatic LEARNBALL climax for the week's work. During the big game on Friday, the LEARNBALL self-evaluator system works very well for me. Each student participates at his/her own level by bidding a point value that is appropriate to the skill level. For example, during the Friday contest, a high ability student may decide to go for 30 points and consequently is asked some rather difficult questions. A low ability student, on the other hand, is free to bid for lesser points and receive an easier set of questions.

During the exchange, all the students are involved and interested because the answers given are subject to a challenge from the other team. A successful challenge means a double point value to opponents, so it pays for everyone to be attentive. In a typical situation, Susie, representing the Angels asks for a 30 point question on the division of fractions and works it out. She calls out "One and five ninths." Five seconds elapse and no challenge to her answer is issued by the Tigers. The Tigers' coach says, "We accept the answer." Thirty points are awarded to the Angels as Susie's teammates smile at her and applaud the good work. The Angels' scorekeeper records the points on the scoreboard while the team secretary records Susie's 30 points by her name on the team roster.

In a similar fashion, Tommy of the Tigers takes his turn. He is a low ability student and elects a 5 point question on addition of whole numbers. The problem, two hundred thirty-five plus one thousand twenty-nine, is given. Tommy struggles with the problem as everyone else quickly works it out. While his teammates hold their breath, Tommy hesitantly says, "One thousand two hundred sixty-four." Tommy waits. No challenge. Again the Angels' coach says, "We accept." Tommy grins from ear to ear as his team cheers and the Tigers scorekeeper moves the marker on the scoreboard forward another five points.

Letha of the Angels opts for a 15 pointer. The question on division of whole numbers is twenty-eight thousand nine hundred fifty-one divided by seventeen. All heads go down as everyone madly ciphers. Letha writes and then says, "One thousand seven hunnerd and three." Almost instantly, hands shoot up on the Tigers team and the Tiger coach says, "We challenge." The Tigers determine that it is teammate Scott's turn to handle the challenge, so Scott says, "One thousand seven hundred three." Since it is a challenge for double points, and since Scott is questioning Letha's response, he explains the perfectly correct answer should not have included the word and. Also the word is hundred, not hunnerd. Double points are awarded to the Tigers.

At the end of the question and answer session, each team secretary checks to see which member has earned the most points for the team during the big Friday contest. If that high point person has also shown good sportsmanship, then that member is awarded the most valuable player award for that week.

During the final 2 or 3 minutes of class, the teams take a few shots at the hoop with the ball to place final points on the board. The game is over, the Angels win, and the win is recorded on the big win record chart. LEARNBALL teachers use many different kinds of rewards, but in my class the winning team of the week gets a small candy and is allowed to line up and exit the room before the other team. The value or nature of the prize itself is not important, but it is necessary to give the winners some symbol of victory.

With LEARNBALL, I find I'm able to demand a much higher level of performance from my students because they accept those demands as part of their contest. As a result, even low ability students are able to "talk math" to me. They read and write numbers properly; they divide out common factors when reducing fractions instead of cancelling or slashing; and they read parentheses as "the quantity" and "that quantity." It seems to me that, by learning the proper terminology, students find it easier to ask a question and they are able to understand the answer more easily. Keep in mind that the LEARNBALL format does not require a teacher to have these kinds of attitudes. I'm merely explaining how LEARNBALL helps me achieve my goals by providing a lot of reinforcement.

Because the big contest on Fridays is almost always oral, my students develop good listening skills. They pay attention to the action. They are able to quickly and accurately solve the problems. My personal style involves insisting that answers be perfectly stated so that students develop what I feel is a strong mental discipline for the subject. They are not allowed to put a "the" in their response if it should be "that." I'm that strict! Instead of my students resisting that tough discipline as they once did, my teams accept it as part of the LEARNBALL experience.

There are many aspects of motivation in the LEARNBALL model, and I can't deal with all of them here, but a few examples should be mentioned. One big source of motivation is LEARNBALL certificates awarded to the most valuable player, most improved player, most studious, etc.; and the certificates are printed so that a blank space can be filled with any kind of award the team and teacher feel is right. It has been my observation that these LEARNBALL team certificates are highly treasured, often framed, and kept for years.

Students elect to use LEARNBALL at the beginning of the year and are periodically asked to vote to continue or discontinue using LEARNBALL. As the year proceeds, the approval factor usually climbs from eighty to ninety percent to a hundred percent acceptance, or very near it. The little rewards built into the system, such as the certificates, make it very stable and popular over time.

I've used LEARNBALL now for 6 years with increasing satisfaction. It is a very easy system to implement and use. There are no workshops or training sessions required. All that is necessary is to follow the checklisted instructions carefully. If problems are encountered, a quick phone call or note to the League produces the answer because experienced LEARNBALL teachers know what to do in any particular situation. LEARNBALL has enabled me to keep my own teaching style and to use the same materials and grading system I used before I adopted LEARNBALL. I use an individualized approach, which LEARNBALL carries beautifully, but LEARNBALL's motivational pattern also supports traditional and other teaching methods.

It is worth mentioning too that LEARNBALL is effective in a wide range of situations. It is used in second grade and with high school seniors. In my situation, LEARNBALL has worked equally well with low ability grouping classes, average track classes as well as advanced placement classes. And as already indicated, the LEARNBALL self-evaluator system accomodates a wide range of abilities within the same class.

I encountered very few difficulties over the years with LEARNBALL. The few problems I did have, such as settling arguments, were easily cleared up by calling the League to discuss the situation with other experienced LEARNBALLERS. In my opinion, problems are almost non-existent because the system has been developed slowly by teachers in classrooms over a period of 15 years. The "bugs" were worked out in a classroom before I began to use it.

Now, teachers have formed a non-profit corporation to disseminate the model further, and, as the number of teachers using LEARNBALL grows, so does the experience bank available to new teachers who have specific questions. At this point, teachers in virtually every subject area and all age levels are using the model in many areas of the country. League members can contact one another for help and suggestions, and this adds a lot to my personal motivation. I think this feeling of strength and support carries over into my relationships with my students, giving me the honest feeling that I can face any problem that comes through the door in September.

While I said there are no problems worth mentioning, that is within a context of one who is very comfortable with the design. Naturally, there would be a lot of problems if the teacher were not comfortable with the general LEARNBALL concept of making learning a sport. So the limitations involve the necessity of liking students to take over certain roles and actively share a lot of the learning experiences usually reserved for the teacher only. For example, if you do not like the idea of students taking a large share of responsibility for keeping discipline, you will not be comfortable with LEARNBALL. The teacher must be able to tolerate some noise and some confusion as students work together in an exciting environment. That is not to say the teacher who likes structure and discipline will not be

happy because I feel I enjoy both of those things. LEARNBALL has more structure and discipline built into it than I could ever get before, working on my own. But to get that, one has to be able to allow students to work around and talk through the problems for themselves. Having said that, I hasten to add that I know LEARNBALLERS who have different feelings on discipline. They are operating in a more relaxed and open situation than I am, but they report good results with LEARNBALL. As I said earlier, whatever style or program you like, LEARNBALL will provide reinforcement and motivation for you, providing you are comfortable with a student-centered, sports format.

LEARNBALL OUTLINE

1. An Alternative, Not a Panacea

LEARNBALL is presented as yet another choice for teachers and not as a panacea. Most LEARNBALL teachers see it as a middle ground between traditional and open classroom organizational plans. It is a peer group organizational design in which the students share the responsibility and the joys of learning with each other and with the teacher. Student energies are harnessed through team spirit; therefore, the model has a distinctive sports flavor that many students enjoy.

2. Total is Greater than the Sum of Its Parts

LEARNBALL has a lot of things built into it, and the end result is much more than could be expected from a simple game or sports format. For example, there are definite steps in which students agree to use the design, and there are elections for various team positions. Consequently, the rights and feelings of each individual team member are not lost for the sake of team effort. LEARNBALL was originally invented about fifteen years ago by a classroom teacher in Pittsburgh who has been improving it during that time. In recent years, many teachers have adopted LEARNBALL and their ideas have also been added.

3. Competition is Intergroup, Not Interpersonal

In LEARNBALL, each team member is free to choose his or her own level of competition, so, in a sense, team members set their own competitive goals. This prevents LEARNBALL from becoming a varsity sport for top skill players only. Nevertheless, there is a strong feeling of team spirit that gives good support to every member regardless of skill level. For example, a football player who makes an 80 yard dash for a touchdown is cheered and acclaimed by everyone whereas a student in a non-LEARNBALL situation who does a mountain of homework, answers a lot of questions successfully, and runs far ahead of the group intellectually is often not held in the same high esteem as the star athlete. LEARNBALL, on the other hand, gives the good student a lot of acclaim because his/her good work adds to the team score as well as to the individual grade. Similarly, a third string football player who does his best, but still fumbles the ball, is comforted and helped over the tough time by teammates. The low ability student who makes a mistake in a non-LEARNBALL classroom situation usually suffers alone with very little solace from fellow students. He or she is not encouraged to try again with a "better luck next time" response from others. On a LEARNBALL team, even

the slowest student can participate by bidding for low-point, easy questions. All earned points help the team, and the few points contributed by the low ability member can make the difference in a close contest. In that situation, a slow student can make the deciding move that wins for the team and become a bit of a hero, which low achievers almost never experience in any other setting.

4. Teacher Mental Health Enhanced by Various Student Roles

In LEARNBALL, students have a piece of the action. There are various student roles such as team leader, assistant leader, secretary, coach, and scorekeeper. When students get involved, it is their activity and not just something they must do to satisfy the demands of the teacher. For example, an active student, who otherwise might present a discipline problem, likes the action and movement of keeping score on the LEARNBALL scoreboard. The nervous energy of the scorekeeper is channeled to a very good purpose, namely the maintenance of the scoreboard. The movement of the scorepieces provides a constant high level of reinforcement for learning to every member of the team. Encouraging students to assume active roles harnesses peer group energy and allows the teacher more time to concentrate on purely learning tasks.

5. League Materials and Membership Make LEARNBALL Easy to Implement and Maintain

LEARNBALL has been developed by classroom teachers for direct use by teachers. LEARNBALL instructions are a series of checklists that tell the teacher exactly how to begin and continuously operate the design, step-by-step. It is a matter of teachers reaching out and communicating with other teachers and explaining what to do and how to do it based on thousands of classroom experiences. Any teacher who follows the checklists is assured of duplicating the success achieved by the other LEARNBALL teachers. Further, MYTEAM LEARNBALL League is a non-profit, educational organization operated by teachers, for teachers. Members of the League not only receive a LEARNBALL scoreboard and instructions, but they also can receive any help they need from other members who have a similar school situation.

Join The League

To enjoy the benefits of LEARNBALL in your learning situation, join the League (two-year membership) and receive the scoreboard and complete instructions. Mail a check, money order or purchase order in the amount of forty dollars to:

MYTEAM LEARNBALL LEAGUE
Box 2152
Pittsburgh, PA 15230

You will receive a two-year membership which entitles you to whatever assistance you need to implement LEARNBALL in your classroom.

For further information or answers to specific questions, call the League on the 'LEARNBALL Hotline' (412) 233-3767.

CURRICULUM DEVELOPMENT FOR SECONDARY
SCHOOL SPACE SHUTTLE USE

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The U.S. Government has set aside a small number of spaces on board its Space Shuttle flights beginning in 1981. These spaces are reserved for private citizens, corporations, and educational institutions to send their own experiments into space. This program is called the "Get-away Special." The cost of the Get-away Special is \$3,500 for 1.5 cu. ft., and \$10,000 for 5.0 cu. ft.

If one considers purchasing space on the Shuttle for a secondary school student experiment, then the educational problems begin to arise. Questions such as, "What shall we teach?", "What methods should be employed?", and "How should these methods be arranged?" must be answered. Also, experiment selection, itself, may pose a problem. Camden city schools, and in particular, Camden High, has come up with an answer to solve its own needs.

Camden is a city of about 80,000 people. Its two high schools, Camden and Woodrow Wilson, have approximately 90 percent and 50 percent black students, respectively. The remaining percentage is composed of primarily Hispanic students at Camden High, and about equal numbers of Hispanic and White students at Woodrow Wilson High. The city itself is in the midst of several urban renewal programs.

The utilization of the Space Shuttle Program by the Camden high schools came about by accident on November 29, 1977. At that time, Mrs. Riletta Cream, principal of Camden High School, and Dr. Irving K. Kessler, Group Vice President of RCA, met at a dinner meeting. Among the topics discussed was Camden High's award winning chess team. Dr. Kessler felt that any school with a superior chess team could do great things in science. He subsequently offered to cover the cost of placing an experiment aboard the shuttle in 1981, if the experiment was conceived and developed by the students of Camden's high schools. This offer mushroomed into a program called "Orbit '81."

Camden High developed its own time line for the Orbit '81 program (see Appendix A). This schedule called for the development of a space science summer enrichment course (see Appendix B), the identification of students who could handle the task, and the development of several year's worth of curriculum which would be designed to help the students select and develop the chosen project. Also, as the program developed, it was noted that there was need for student involvement beyond the core of students, and the need for teacher training.

The summer course was intended as an introductory space science program. The course included: The history of rocketry, fundamentals of rocketry, America's space programs, science-fiction literature, and the resulting applications of knowledge obtained through the space programs.

The evaluation of this course consisted of an objective pre- and post-test, and a questionnaire about the course itself. The results of the cognitive test and the questionnaire indicate to this author that the course met many of its objectives, and should be offered again.

At Camden High, each incoming freshman is given an academic rating based on the results of a skills battery, and teacher evaluation. Thus, students are subsequently placed in English, mathematics, and science classes homogeneously. The author in his role as Science Department Chairman, selected one of the highest level classes as the Orbit '81 class. In this case, twelve students became the core of the Orbit '81 program.

Our school board has indicated that the curriculum for this program should be developed one year at a time, and rightly so. Each succeeding year of curriculum is based on the needs of the students with regard to the experiment selected, and the progress made.

Our students will not be selecting their experiment until nearly the end of the first year of Orbit '81. Therefore, the author and Mr. Nick Timpanelli of Woodrow Wilson High developed the first year's curriculum with two concerns in mind. First, what general knowledge would the student need to make a rational decision about a possible experiment to interface with the Shuttle? Second, what already exists within the school system that could be adopted or modified for this program? A flow chart that led to the specifics of the curriculum is indicated in Figure 1.

The modules "What's Up," "In Orbit," and "Winds and Weather" are part of the ISCS series published nationally by Silver-Burdett Co. The modules allowed the students to get a broad understanding of the rudiments of rocketry, orbital mechanics, and the earth's ambient environment. ISCS is generally considered to be a "hands on" method of teaching science.

The electronics module was developed with the help of RCA's engineers. Because of the general nature of the first year's program, the curriculum began with the fundamentals of electricity. Among these topics were: Introduction to DC and AC, how resistors, inductors and capacitors work, and how to use an oscilloscope. Later in the module, logic and digital fundamentals were included. Through the development of lab exercises, the "hands on" approach to learning was maintained.

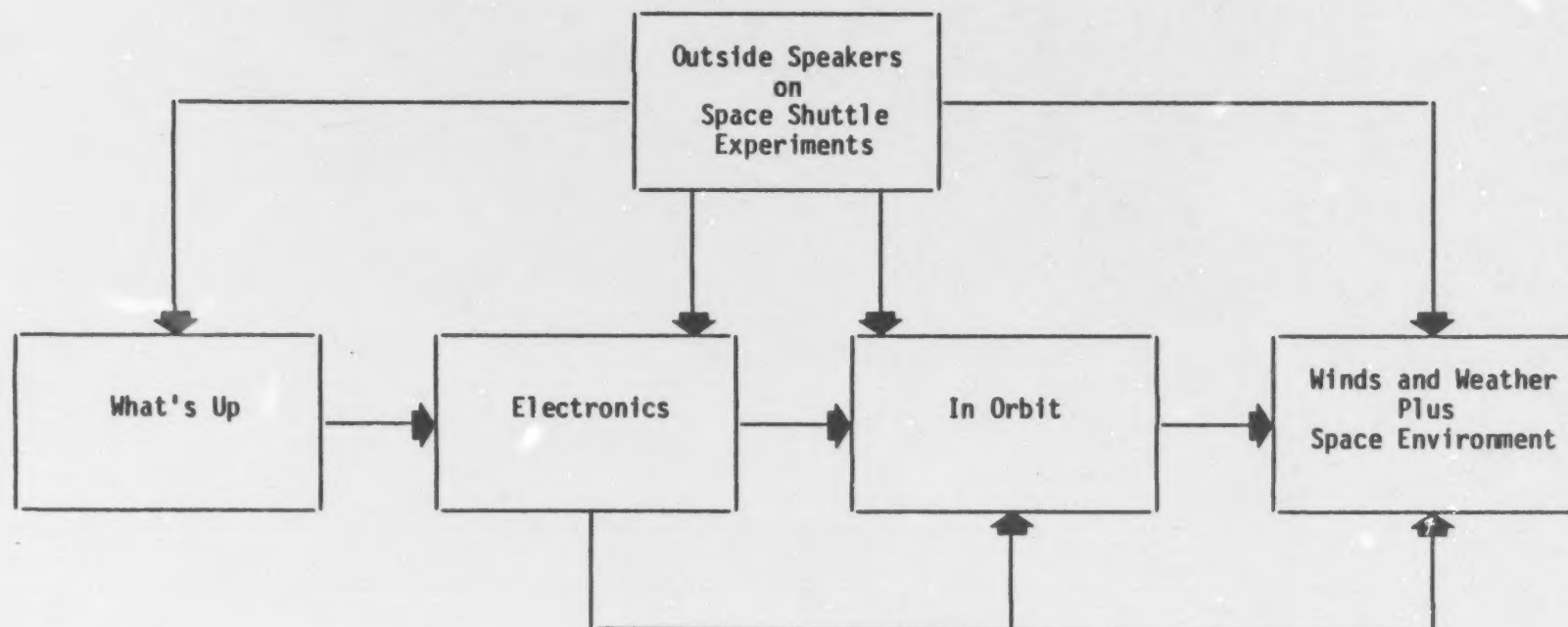
The space environment module was developed through the gleaning of material from several texts. The space science module was designed to teach the students about the radiation and vacuum of space, and how these phenomena effect life on earth, and satellites in space. Once again, experimental exercises were emphasized.

One of the objectives that we set out to achieve was to involve, in some way, as many people in the school as possible. We therefore created an Orbit '81 club and a rocket club.

Members of the Orbit '81 club came with all kinds of interests and backgrounds, and who wanted to apply these interests to furthering the Orbit '81 experiment. One group became responsible for producing assemblies about

Figure 1

ORBIT '81 FLOW CHART
FIRST YEAR



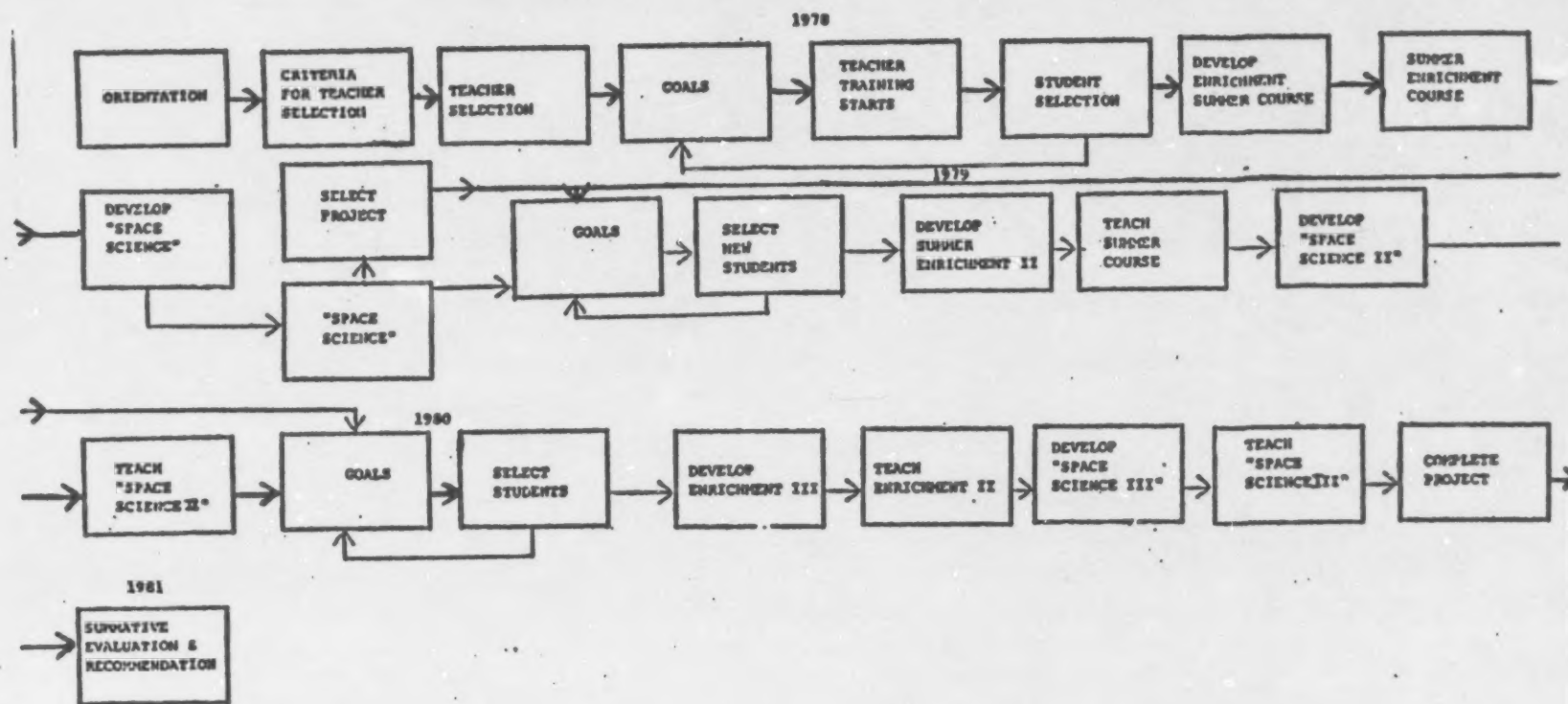
space, another group acted as hosts and hostesses for outside speakers. Still, a third published a bi-monthly newsletter about Orbit '81 activities. A fourth group showed interest in cataloging our space-science books and magazines for a library which our school will establish. Artistically inclined students began painting walls of the school with murals. Finally, students interested in photography became our "historians."

The rocket club is composed of students who have a desire to build and launch model rockets. They meet once or twice a week after school. Funding for this program came through a small school board grant.

In addition to providing a worthwhile outlet for students, these clubs allow for different teachers to become actively involved in Orbit '81. Other ways that teachers from many disciplines became involved were through our assemblies and trips. Also, the published curriculum listed specific ways that many subject areas could become involved in studying space science.

What does the future hold? We hope to continue the summer enrichment course in space science, as well as develop new curricula for the core of Orbit '81 students, based on the selection of their experiment. There are a number of unresolved questions at the writing of this paper. For example: For how many periods should this program be taught next year; should Orbit '81 be taken in lieu of or in addition to tenth grade biology, and finally, has our first year been successful enough to inaugurate an Orbit '82 class?

Another concern is: Can we keep the momentum and interest of our students and teachers going? We will try to do so through additional trips, assemblies, club activities, and in-service courses. We are confident that a minority populated school can succeed in this pilot endeavor.



CAPDEN HIGH SCHOOL
TIME LINE

APPENDIX B

ROCKETRY AND SPACE TECHNOLOGY: A SUMMER ENRICHMENT COURSE

Rocketry and Space Technology has been developed as a 60-hour teaching course. It has been designed to offer students a broad background in the history and theory of rocketry, as well as the history and development of the American Space program. Its intent is also to improve proficiency in certain math skills through computations involving rocket and space experiments. This course will allow the student to explore present-day controversies between science and society by way of science-fiction literature.

Units of Study

- I. History of Rocketry
- II. Rocket - theory
- III. Rockets - experiments
- IV. American Space Programs
- V. Science and Fiction
- VI. The Earth From Space
- VII. The Solar System and Deep Sky Astronomy

The broad aims of the rocketry and space technology course are to excite the students' interest in rocketry and space technology, and to help the student gain:

- ° a broad base of knowledge of rocket and space technology
- ° an awareness of the advances in knowledge about the solar system
- ° an understanding of the applications of the results of space technology in everyday life
- ° insights about corporate use of space technology to develop new products
- ° a desire to pursue additional science and math courses

BEHAVIORAL OBJECTIVES

To have the student be able to:

1. Write a brief history of rocketry
2. Identify Robert Goddard, Wernher von Braun, John Glenn, Neil Armstrong, Astronaut, Cosmonaut, Viking, Mariner, Skylab, and Space Shuttle
3. State Newton's Third Law

4. Identify action and reaction in a given problem
5. Solve problems using Newton's Third Law
6. Identify from photographs, the experimental aeroplanes and rockets that played a role in America's space history
7. Identify the dates of the launching of Sputnik I and Explorer I, as well as the date of the landing on Mars and the Moon
8. Identify three seas or three craters on the Moon by name
9. Be able to chemically test for protein
10. Observe, on film, the lunar landing
11. List recent findings about the Moon, Mars, and Jupiter
12. Observe, on film, the launching and landing of the Viking probes to Mars
13. Identify Nix Olympica on the surface of Mars, from a Map of Mars
14. List, and briefly discuss in writing, recent discoveries about Uranus
15. Simulate a lunar landing using the NAFEC computer
16. Explain why astronauts feel weightless in orbit around the earth
17. Multiply and divide with powers of ten
18. Calculate the force of gravity between the earth and moon, using Newton's Law of Universal Gravitation
19. Simulate and observe stellar parallax
20. Identify all the planets in our solar system from pictures and slides
21. Observe a rocket being launched
22. Calculate the speed and acceleration of a rocket in flight from a super-8mm film
23. Observe what space-related scientists and engineers do
24. Observe the motion of people and things in a weightless environment
25. Describe the job and function of an astronaut, aeronautical engineer, exobiologist, and an astronomer
26. Analyze the probability of life on other planets in the universe

27. Speculate on what other life might look like
28. Measure the diameter of the sun and moon
29. Use the method of triangulation
30. Explain the benefits of space technology in the areas of safety, agriculture, weather, navigation, astronomy, and oceanography to people on earth

SCIENCE - FICTION LITERATURE

The Black Cloud

31. Identify the constellation Orion from a photograph
32. Identify Mt. Wilson and Mt. Palomar from a photograph
33. Discuss the possible roles of scientists and politicians in society
34. Discuss the need to give the public information of a scientific nature vs. withholding it for national security reasons

It is also desirable to take the students to the Smithsonian Institution, so that they can see many of the things discussed in class first hand.

A TEST

I. MATCH

- | | |
|------------------------|-------------------------------------|
| 1. Exobiologist | Father of American rocketry |
| 2. Viking I | Looks for life outside of earth |
| 3. Space Shuttle | Father of German rocketry |
| 4. Saturn V | American in space |
| 5. Astronaut | Russian in space |
| 6. Robert Goddard | Rocket to photograph Mars |
| 7. November, 1957 | Rocket to land on Mars |
| 8. Jan. 31, 1958 | Took astronauts to moon |
| 9. Wernher von Braun | Sputnik I launch date |
| 10. Cosmonaut | Explorer I launch date |
| 11. Mariner | Tallest volcano in the solar system |
| 12. July 20, 1969 | Landing on Mars |
| 13. Sea of Tranquility | Landing on moon |
| 14. Nix Olympia | Lunar area |
| 15. July 20, 1976 | Took pictures of Jupiter |

II. Draw a rocket in flight and label action and reaction.

III. Why do astronauts feel weightless as they circle the earth?

IV. List three space related jobs, and the function of each.

V. Complete this data table:

d	t	$d_2 - d_1$	$t_2 - t_1$	$S_{\text{ins.}}$
0	0			
10	1			
18	2			
24	3			
28	4			
30	5			

VI. List the earth benefits which resulted from space technology in: agriculture, weather, astronomy, and oceanography.

AMERICAN STUDIES AS A MODEL FOR PLANNING AEROSPACE EDUCATION PROGRAMS

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This paper is the outgrowth and result of planning for the Radnor, Pennsylvania, "Space Awareness Days" program. The stated purpose of the program was to: (1) involve the whole community in a unique teaching experience to make students and adults more aware of the immediate benefits of space exploration and science; (2) to further involve them in a learning situation that would internalize their knowledge; (3) to utilize one of the most relevant current topics of general interest (after all how can you beat "Star Wars", "Close Encounters", and "Battlestar Galactica" for interest motivation?) to promote further study and inquiry; (4) to give the community at large and its future citizens the useful "fall out" of space related medicine, industrial research and products, and human knowledge services, such as agricultural improvements, environmental aids and similar programs enriched and benefited by space technology.

This report will deal with three essential components of the program. First, the theoretical base; second, a general summary of the program as it emerged through committees, cancellations and adaptations; and third, some suggestions of other potential ideas that either failed or were conceived too late to be implemented.

THE THEORETICAL BASE

The American Studies approach was used as the working model. This multi-disciplinary method by its very nature reaches students where one approach alone might fail. Simply stated, this approach assumes that each discipline so used will retain its own methodology, language, and approach in focusing on a period of human existence, theme or problem. I believe, in an exaggerated form, the space program demonstrates the vital factor of the interrelatedness of human knowledge. Certainly, in the multitude of benefits and programs spawned by space-related research one can find virtually every academic discipline represented. If this fact is made part of the planning for science programs a child not otherwise interested in science may enter the "backdoor" of mythology that we commonly associate with the ancient Greeks or Romans (or American Indian groups)¹ combined with a unit on astronomy, or they may find the literature of space travel in science fiction the key to the door of science.² The American space program, used imaginatively, can find some slot that appeals to virtually every youngster.

¹ See the interesting approach of James Sweitzer of the Adler Planetarium in Chicago, discussed on page 66-69.

² For example, the suggestion by Samuel F. Howe (also discussed on pages 44-46) to me privately that his unit organized around a long term trip into space should have addressed the necessity of communicating with intelligent life forms should they be encountered. C.S. Lewis had as his most successful space traveler in Out of the Silent Planet, none other than a linguist.

An interdisciplinary methodology also recognized that the human being functions and learns in patterns. Normally, the more exposure to ideas, and ideas of a widely dissimilar nature, the more we try to integrate this information into meaningful patterns. As a young graduate student I read that any history worthy of the name had to be comparative in nature. We have to teach the fundamentals of writing English, the ideas and developments in history, and the methods and results of chemistry or biology. But somewhere along the educational path we must recognize that this excessive compartmentalization runs counter to the brain's normal function. This compartmentalizing knowledge as important as back to basics may be, has contributed to students in college who write superb papers in English composition, but appear virtually incoherent in written work for history classes. Space exploration and science demonstrates the cohesiveness of knowledge not only from science to science, but also between sciences and other disciplines.

The young child does not have to be taught to detect patterns in human knowledge. They do this normally as a part of growing up. I have found from personal experience that my two children draw comparisons that did exist in which I saw none. My training had taught me to think in a stylized form. Perhaps some of our training is too much in the mold of Pavlov's dogs. This action-reaction method overlooks, and I think, destroys the natural curiosity of the child to make sense out of the world in which he lives. What we may see as a strangely keen insight on the part of a child may well be the recognition of a pattern that we have missed.

The observation that the brain is similar to a complex and ultimately superior computer is a strong argument for interdisciplinary science programs.³ The more raw data that is fed in, from a wide range of sources, with the stimuli of many disciplines, the more this complex device will attempt to make comparisons. In fact, with this method, a very young child may move up the taxonomy of educational objectives to include making inferences, extrapolations and other advanced thinking skills.⁴ The more avenues that are explored, the more meaningful and total the knowledge. The more disciplines that can be brought to bear on a given subject, the more likely you are to insure the improvement of recall by building associations.

I read recently that the brain is similar to a vast universe in which systems exist within systems, which also relate to other systems, and on and on infinitely. Thus it would seem there is an infinite number of methods to turn on a brain and start it in motion. An interdisciplinary approach, such as American Studies, attempts to provide as many components of the learning experience as possible. It recognizes that learning is cross-disciplinary and this is the real return to "basics". The learning of primitive man was essentially comparative, searching for meaningful patterns, correlating them and making assumptions: the beginning of the thinking process.

³ The best summary article I have seen on this is Leslie A. Hart, "Brain Compatible Teaching," Today's Education, November-December, 1978, pp. 42-45.

⁴ See Bloom, Benjamin S., Taxonomy of Educational Objectives, (Longmans, 1956).

Several ideas in the teaching-learning process that most successful teachers know can be utilized here. First we know that the young must verbalize to learn. In the introduction to this conference, Dr. Kerry Joels, of the National Air and Space Museum, related an experience in which he was able to successfully communicate with a class that other teachers had written off as a failure. He did this by never telling them to "stop talking" (which may mean to the young person "stop learning") but by moving from what some of the students were discussing to his subject matter. Space has the range of interest that can elicit some verbalization from almost every child.

Learners need to use materials, to have physical involvement in their subject matter. Science projects and units have a unique advantage here over some other subjects. Moreover, learning proceeds at a more rapid pace when dealing with real problems and situations. Space is not only interesting because it is futuristic, but also because we already live in the space age. It's relevant. A unit prepared around real problems (like Howe's) is thus going to have a better chance of success.

The Radnor program was not geared to reach either specific ethnic groups or females. It was based on the idea that if we could utilize as many disciplines and programs as feasible in our time period we would reach most of the students. Specifically it is my belief that female students are as interested in space and science as their male counterparts.

A SYNOPSIS OF THE RADNOR PROGRAM

The core of the two weeks program from April 23 to May 4, 1979, was the visit of the NASA "Spacemobile."⁵ Four educational specialists from NASA gave assembly programs in all the Radnor public schools, Valley Forge Military Academy, Archbishop Carroll High School, and Eastern College. These assemblies dealt with the history of flight, the scientific theories and discoveries behind modern space travel, as well as the dynamics and day to day problems confronted in space. They used models and audio-visual materials to highlight concepts. The material covered was geared to the level of the student assemblies. Following this the team members made individual class visits covering topics of interest, sparked by the assembly, or in connection with the curriculum covered by that class.

This NASA team also provided a workshop for science teachers of Delaware County. The purpose was twofold: first, to demonstrate the methodology and materials that could effectively integrate space related sciences into the regular course offerings; and second, that this program would not be a

⁵ The Spacemobile program is available from each NASA center in the United States by reservation. It is free and an invaluable resource for science programs. Currently, there is a long backlog of schools waiting for this program.

"one-shot" attempt, but would be the the beginning of an on-going instructional approach.

The schools planned their science classes around the space theme for the Spring. Subsequently, at the elementary schools rocket clubs were formed and successful launches were made. One elementary school planned a balloon launch with some interesting side effects. Taking a regular, but helium-filled balloon, they attached a self-addressed and stamped envelope to the balloon. It asked the finder to note where the balloon landed. The launch itself had its own appeal with approximately 700 balloons shooting skyward in unison. But it also appealed to the stamp collectors in the group (your own first day of issue stamp that had traveled into "near-space.")⁶ An unexpected side effect is that some of the children have made pen pals. We were lucky in that about 20 percent of the balloons were returned. One traveled over 100 miles to Long Island, New York.

The middle school developed an "egg-drop." Assisted by the Philadelphia Electric Company's helicopter they attempted to simulate a "soft landing" on the moon. Eggs were packed in styrofoam, newspaper, plastic wrapping, even peanut butter, with the intention of finding what material was best for landing intact. The event was designed to bring home to students some of the problems of space travel.

The social science classes were introduced to the vast possibilities of space applications by a team of experts from General Electric. Strong support in the form of ideas and programming came from M. James Polski of GE's Space Division at Valley Forge. Their program entitled "Earth Resources from Space -- a Current View of Landsat Programs Applications," emphasized the human uses and by-products of discoveries in the space program. As a major contribution to America's Landsat and other space programs, GE was well adapted to do this. As a supplement to his and other parts of the program, one of the high school gyms was devoted to a large exhibition open to the public and to various classes. Multi-visual exhibits were provided by GE, Philadelphia Electric Company, General Foods, IBM, McDonnell Douglas, Bell Telephone, RCA, and Black and Decker. A very popular item was a mock space shuttle which could be handled by the inquisitive visitor.

The History Department at Eastern College planned a "History Day" program for secondary school students. It featured student essays on the history of space exploration and science. It was designed to run on the model of a scholarly convention, and appeal to those students interested in writing and research.

The Radnor program also included a number of "Specials." One was a traveling exhibit provided by the Philadelphia Electric Company. This was specifically aimed at energy conservation and included an audio-visual

⁶ The idea of the first day of issue stamp came from Lee Sagesar, Archivist of NASA, Washington, D.C.

presentation and explanation by one of their personnel. The exhibit was highlighted by a solar powered doll house, and kite safety. The same company presented the "Miracle of Electricity" utilizing a bicycle and showing how much or how long a person would have to ride it to generate enough energy to power a light bulb. These interest-catching models were very effective in the schools where they were used.

Eastern College used its planetarium to present "The Legacy: The Story of American Achievements in Space," designed by NASA and programmed by Eastern especially for Space Awareness Days. School children were taken here for field trips weeks before the main program, and it was open to the public during Space Week.

The discipline of economics was introduced by the Eastern College Business Department in cooperation with General Electric. Together they presented a program designed by Mr. David W. Keller, General Manager of Advanced Space Programs at GE. This multi-media discussion of "Space Programs and Benefits," was geared for the college audience and the business community. However, as presented in the public meeting, it was enjoyed and understood by both elementary and middle school children in the audience.

In a schedule dotted with highlights, two of the most outstanding were the visit of Dr. Ed Gibson, NASA astronaut and holder of America's record for the longest time in space. He is currently leading the training of the Shuttle pilots. He presented an informal and autobiographical story of his personal exploration of space. This was illustrated with film clips and slides. The question and answers that followed went on for over an hour with all ages represented among the questioners.

The Radnor program was not timed to follow precisely the Jupiter fly-by. But it did. As a result, our program was immeasurably enriched. Our second major highlight for the community was the day that astronomer Dr. Edward Frey of NASA spent in the township. He had both a short clip and slides of the fly-by which he demonstrated for groups ranging from middle school through college. The importance of space exploration related to weather studies was particularly evident in his presentation.

The response to this two week, volunteer based program, run on a financial shoe string, was overwhelmingly favorable. As it stands, it is a suggestion of the untapped potential of the American Studies, interdisciplinary approach for planning space-related science programs.

POTENTIAL IDEAS

One lesson for a parent volunteer attempting to create and implement a program of this nature is that it is too big for a volunteer. This is not true at the idea stage. However, in implementation it is absolutely essential that the person who chairs the effort, whoever that may be within the system, be the one that can motivate, facilitate, and otherwise move all necessary personnel to the successful conclusion of the program. Obviously this would be necessary if the program is incorporated within the regular curriculum.

A program planned to utilize industrial and business participation can be highly successful and enriching. Relevancy is apparent for the career-orientation of much of the programming. Every group that we contacted was more than cooperative. However, the excellence of our presentation would have been vastly improved if we had begun this part of our effort a year in advance. Scheduling of exhibits and personnel is often done at a minimum of a year in advance.

Beyond these generalizations I had specific programs that did not materialize. We had hoped to emphasize artistic creations, but partially failed. On the elementary level the art teachers cooperated and the students did use various mediums to illustrate a space motif. Some science projects of the solar system or space models were definitely works of art. Our plans to have a display of works by practicing artists that were inspired by space or flight themes did not materialize as we could not locate any. (In fact we were to use display space made available to us by various businesses in Wayne.) Something of the nature of the creations displayed at the Smithsonian Air and Space Museum would be particularly effective as an attention getter for the programs. Additionally, some of the futuristic ones dealing with space as a human habitat would be effective discussion starters for classes in all disciplines. The need for artists in drafting and conceptualizing space components would strike a career interest. As strange as it might seem initially, art is one of the humanities disciplines that can be effectively worked into a science program.

A more difficult subject, perhaps, would be the integration of music. An unused idea of one of my children was to tape music from various compositions of space themes and use this for background to early morning school announcements. Or, it would be piped over the public address system when classes were changing during the Space Week. It is only in the recent past that I have heard the themes from "Star Wars" and "Close Encounters" performed by student groups. If you have more musical resources such as a local orchestra or organist, then music ranging from one of the early inspirations from space exploration, "TeleStar," to the music of Gustav Holst's "The Planets" would make a particularly rich addition to the program.

We also made a feeble, but belated attempt to incorporate the field of literature into our program. Science fiction is an area of enjoyment reading that appeals to many, but not all, people. Literature units planned around this theme can supplement the sciences while still teaching those objectives necessary in the field of literature. I would argue, in fact, that in reading some themes from science fiction we are reading future history. Jules Verne's contribution to this concept is not arguable. Other themes such as morality, hero-types, mythology, character development and questions of good versus evil are easily borrowed from such writers as C.S. Lewis, Isaac Asimov, Arthur Clarke, Ray Bradbury, and Robert Heinlen, to name only a few. We had hoped to attract an author, but financial limitations prohibited this. To include the above ideas we would have had to start over a year in advance for curriculum planning and this was not possible. Our final resort was to solicit the aid of the public librarian who graciously set up a display of science fiction works from their holdings.

The incorporation of other forms of literature such as biography and autobiography has been effectively pointed out by another participant, David Vaughn. It should be noted that here both the social sciences and humanities can be united in exploring themes that would eventually enrich the science department's motivation. This may be the classic example of how a well-planned interdisciplinary program can break down that artificially developed idea that knowledge exists in segments. We do this in part by making students leave history in room 202 to go to math or science in room 301, or even another building. To deal with the same ideas and material in several classrooms would be the ultimate in reinforcement.

Films can also be an effective coordinating agent. Two immediately come to mind: One is "2001: A Space Odyssey." Provocative ideas for both social studies (anthropology) classes and computer classes (math) come to the fore. Or the newly released "Night Flight" for T.V. (produced in January, 1979), which comes packaged for the teacher with behavioral objectives and lesson plans, is a second type. Both of these are examples of how space as an idea utilizing different mediums can be a bridge not only between disciplines and different members of a faculty, but also the key to unlock hidden interests of children in science.

Hopefully, the following paraphrase will not do an injustice to John F. Kennedy. He once said:

The exploration of space will go ahead, whether we join it or not . . . We choose to go to the moon . . . in this decade and do other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept.

We should say as educators, "The exploration of the space theme will go ahead whether we use it or not. We choose to develop it because it is challenging and relevant, because that goal will serve to organize and integrate the creative forces of our faculty, utilizing our best energies and skills, and because it is the challenge of meeting the future now."

SPACE TECHNOLOGY AND
ITS MULTI-CULTURAL APPLICATIONS

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Close to the heart of the American Indian way of life is the process of communication. Aside from the passing of the heritage of oral tradition, many Indians have made much use of the means of public address.

Today, with the reality and seriousness of the energy situation, increased costs of travel, and critical issues that face all tribes, the job of tribal officials and government leaders continues to be more demanding. Tribal needs for direct participation in the legislative process get stronger, along with improvement of other social needs--education, health, vocational training, protection of cultural heritage, and dissemination of information.

As the problems tribes and the government must deal with become increasingly complex, it has been shown that satellite communications can be made accessible to just about anyone anywhere, especially citizens from smaller communities and rural areas.

A number of tribal chairmen and national Indian organizations have expressed their interest in utilizing some of the appropriate technology that has been made available to the public through recent advances in research and development of space applications.

The interest shown by Indian leadership to utilize the National Aeronautics and Space Administration's capability to transfer appropriate technology to tribes for use in achieving some of their reservation concerns, has resulted in an American Indian satellite demonstration. This first practical demonstration of a satellite communications ability to provide televised conference and programming for American Indians was conducted at the Crow Agency in Montana and the All-Indian Pueblo Council in Albuquerque, New Mexico, on April 10, 12, and 14, 1978.

The tribes in Montana and New Mexico utilized the satellite to communicate with each other and with federal officials in Washington, D.C., to exchange information and views on education, agriculture, health, and other tribal concerns.

The basic purpose of the project was to evaluate, through an actual demonstration, whether satellite communication can provide a new and beneficial mechanism for communication applications pertaining to Indian affairs between tribes, educational institutions, and the federal government. Any broad-based communication system must be capable of integrating several tribal considerations, and not be limited to education. However, since its primary use would be for education, let us focus on some important aspects.

Born here many ages before others came, American Indians had the entire country to themselves -- its mountains, lakes, streams, forests, prairies,

and game of all kinds. Our school was the great outdoors, and Mother Earth was our teacher. As a societal unit the tribe or clan functioned to meet all of its members' needs. It totally controlled the socialization (education) of its members.

Today, the most critical Indian resource we need to develop and also to protect is our children. Change does not come quickly, but history shows it always comes. We recognize that if we intend to live in the future, we must prepare for it. We are beginning to perceive education as a tool to help us preserve our people, and the utilization of science and space technology can assist us in the process.

Since our very survival is dependent upon how well we are prepared for the future, none of us should play down the importance of the technical opportunities available to us. It is necessary that we have the knowledge and understanding of how to survive in a technology oriented world. In particular, space technology, as an aid, may help us to combat the social and environmental forces that are gnawing away at our people.

The motivations to pursue future satellite communications for people in remote areas are thus twofold: (1) to provide educational services to people not able to attend a university campus, and (2) to explore various social and cultural studies with interested institutions and museums.

This type of technology is a new and promising means of providing education to native people--men, women and children--who are not present in the same classroom as the instructor.

Extending the reach of the university is an obvious benefit to people in remote areas and requires no extensive justification in this paper. A new variety of creative education and cultural programming could be provided to people who are unable to travel long distances to attend a campus learning environment.

The main essence of using this communication technique is to provide an interactive relationship between the teacher and the students. Interaction is the element which transforms information into the process of instruction. Hence, satellites could bring cost-effective services to people wherever they may be located, and without any disruption to their family, geographical, or cultural ties.

With regard to the value of the demonstration to the Indian community, satellites may not be the best answer to our needs; but they certainly represent one of the directions which needs further exploration. The demonstration provided tangible evidence of tribes and individuals working together to realize and achieve a common goal. Certainly, an atmosphere of unity and cooperation prevailed. The fact that the communication process occurred and was interactive on behalf of all the participants, served to illustrate the benefits of the system and the successful accomplishment of the demonstration objectives.

We must explore available technologies that will work to preserve what little there is left of the culture and life of a great people. It is

anticipated that future development and implementation of satellite communications among American Indian and Alaskan natives will receive their cooperation and rekindle their hopes.

To not pursue a future assessment of the merits of utilizing available technologies and the merits of science education would be analogous to turning back the hands on the clock of progress, and a delay, if not a halt, to the self-determination of all native peoples.

THE MATH ANXIETY WORKSHOP: THE UNION OF GESTALT PROCESS AND MATHEMATICS LEARNING

By:

Bonnie Donady and Susan Auslander
Overcoming Math Anxiety
Hartford, Connecticut

Mathematics anxiety is an experience of mental disorganization, panic, and fear that prevents a person from learning mathematics. Many highly motivated and otherwise successful adults avoid tasks that involve mathematics and other quantitative operations. As students they avoid quantitative courses and, as a result, exclude themselves from many careers and disciplines. After years of disuse the mathematical competence and confidence of these individuals may be so low that they experience anxiety when figuring a tip, submitting a budget, or completing a required math course.

Educational institutions, businesses, and industries are recognizing this situation and are designing alternative programs to help individuals rejoin the mathematics mainstream. Our math anxiety workshop, co-led by a counselor, Bonnie Donady, and a mathematician, Susan Auslander, is one such program. Participants in our workshop reduce the degree of their math anxiety and move back into classes and situations involving mathematics.

The immediate purpose of a math anxiety workshop is to allow individuals to relive and thereby overcome their negative experiences associated with learning mathematics. Our math anxiety workshop is neither a math class nor a therapy group; it is in fact a hybrid of the two. It is the blending of Gestalt therapy techniques with mathematics pedagogy that characterizes our math anxiety reduction technique. We will describe this combination of two activities, usually considered unrelated.

General Methods and Goals

The central task of our workshop is to uncover and then to change habitual responses that have previously blocked learning. Through the sharing of math autobiographies, past math experiences are elicited for clues to sources of tension. Later, members develop ways to handle the tension they experience through breathing and relaxation exercises, monitoring of reactions and feelings when given a mathematical task, and a focus on mathematical word problems. Working in small groups of two or three, which encourages risk-taking and sharing of feelings, we stress cooperative problem solving rather than competition. It is an ultimate goal of our workshop that participants develop the confidence needed to return even to a difficult mathematics situation.

There are important differences between the workshop and the ordinary math class. In a math class the teacher is mindful of atmosphere and tone, but such considerations are usually secondary to increasing students' mathematical competence and covering a syllabus. Mathematical competence is often achieved in our workshop but not through a specific syllabus. Instead, math problems are used to examine the participants' underlying feelings when confronting a mathematical task. We give no tests or grades.

Although team teaching is used for certain disciplines in school and college, mathematics is generally taught by one teacher. Our use of a team, including a counselor, is an innovation that allows the members of the groups to focus on the feelings surrounding the learning of mathematics. We stress the process of learning mathematics as well as the emotions that are associated with that process.

Emotions are also the concern of group therapy. While our workshop employs the techniques of group process and awareness used in group therapy, it concentrates on mathematics and math-related situations. We help members become more comfortable with mathematics and find new ways to handle what have been, and in some cases continue to be, negative and unpleasant experiences. In traditional group therapy, the therapist encourages the participants to deal with a broad spectrum of stress-related issues. In our workshop, we are careful to keep the discussion directed to math-engendered emotions and to avoid wider and more complex emotional issues.

We believe that change is possible and communicating this belief to the participants is important to make our workshop a success. As leaders of many math anxiety groups, we have seen this change occur in hundreds of participants.

Participants

Members of a math anxiety workshop are drawn to this program because they have had many negative experiences with mathematics. Although their mathematical backgrounds may vary to a wide degree (from difficulties with arithmetic to difficulties with calculus), their physical and emotional responses are similar. Unless the workshop is sponsored by a school or organization, the members also vary in age, socio-economic background and need for the workshop. A college student may be trying to build confidence to take a required math course. A worker will want to improve his/her chances for promotion on the job. Others want to overcome a pattern of avoidance to daily routines such as tipping, check balancing, and comparison shopping. Participants are often astonished at the similarity of their responses to math considering their heterogeneity as a group, but they quickly identify with one another and support one another's growth and accomplishment. We strive to help the group members identify their common difficulties and to analyze their individual learning patterns and needs. Members no longer want to hide their fear, and as they build self-confidence and increase self-esteem they no longer have to.

The typical workshop format focuses primarily on anxiety reduction and meets for one and a half hours over a six-week period, with ten to twelve participants in a group. As in group therapy, we concentrate first on establishing a safe and trusting atmosphere. A living room environment is preferred.

Gestalt Exercises -- Role of the Counselor

Some concerned math instructors lead math anxiety workshops to alleviate students' fear of mathematics by emphasizing questions, using concrete materials and mathematical games, and controlling the tension that arises. While such an experience can be valuable for a math anxious person, it may be

insufficient to relieve anxiety or to build sustained confidence. Sometimes it can actually create a condition of dependence between this "unique," considerate and well meaning teacher and the student. Our math anxiety workshop, led jointly by a counselor and math instructor, encourages the student to increase his/her sense of power and independence and to try new situations. At the conclusion of the workshop the participants rather than learning mathematics have mastered how to learn mathematics and how to decrease the tension in the math situation.

In the first few meetings, Bonnie the counselor who is trained as a Gestalt therapist is the primary leader. Her presence distinguishes the math anxiety workshop from a supportive math review class. What follows next is a description of how Gestalt therapy techniques are applied to teach participants to handle math anxiety tension, build confidence, and discharge the accumulated years of frustration and hostility.

The techniques we have used include instruction in awareness, diad experiment, here and now experiments, fantasy experiences, role playing, and polarity work with chairs. Other counselors may use systematic desensitization, assertiveness training, values clarification, behavior modification, hypnosis and Weinstein's trumpet.

Awareness

We ask participants to study acutely their contact with objects and events of the outside world (what they actually see, smell, taste, and touch) particularly when math emotion is involved. Next, we ask them to focus their attention on their inside world (what they feel inside their skin, itches, sweaty palms, muscular tension, difficulty in breathing, stomach pains, etc.). We ask group members to observe where and how in their body they experience tension when they confront mathematics and precisely how they feel when they feel dumb, blank out, or freeze.

Since awareness of thoughts, ideas, and mental messages is a key to managing math anxiety, we teach members to listen to one another and become aware of negative or debilitating "I shoulds." For example, participants frequently remark, "I should solve this math problem fast." Participants also become alert to their tendency to characterize the mathematics they do well as not real mathematics. The classic statement of this is "If I can do it, it isn't math."¹

Diad Experiments

The Gestalt sentence completion exercise complements the math autobiography (the focus of the first session). Pairs take turns completing such stems as: "When I can't do math I....." or "If I could do math I would....." Each partner completes the stem with five responses and then each pair shares reactions with the entire group.

¹ Awareness by John Stevens (Bantam 1976), offers numerous experiential exercises applicable to math anxiety reduction.

Participants practice noticing body clues in pairs. Each partner will tell the other what he/she notices in his/her body when he/she is attempting to solve a math problem. This awareness develops over time.

Role Playing

We have experimented with role playing in two different situations. One which takes place about midway in the course involves the entire group's pretending to be in a "regular math class." Participants seem to benefit from this exercise as a means of proving to themselves that they now have some power over what has previously been a stressful situation. Another use of role playing is with individuals. We ask someone to imagine a particular teacher "present" in the room. For example, "Imagine that your geometry teacher is here now. What would you like to say to him/her?" This can be useful for the person who has "unfinished business" (unresolved issues) with that teacher.

Relaxation

We have instructed participants to try different breathing and relaxation exercises to alleviate tension. We teach participants to inhale a deep (unforced) relaxed slow breath and exhale the breath slowly in the same amount of time it took to inhale. We ask the members to notice their breathing and to develop awareness of the whole process. We also teach them to relax by inhaling deeply permitting their "belly" to expand (not puffing up the chest). This extension of the abdominal muscles lowers the diaphragm and creates a larger cavity for the lungs to expand. This is the natural and most efficient way of breathing, hence the most relaxing.

Math Diary

We encourage participants to keep a diary or journal throughout the workshop noting successful and unsuccessful math experiences during the week as well as changes in feelings, attitudes and behavior.

Polarity Work With Chairs²

We have helped math anxious individuals resolve conflicts about mathematics using the Gestalt "chair" technique in a private session.

For example, a person may be undecided about whether to stop taking mathematics. Bonnie asks the person to polarize his/her feelings about mathematics by completing two different sentences. Sitting in the blue chair, the person would complete a sentence beginning "I want to take mathematics because..." In the red chair he/she would finish the sentence beginning "I want to drop mathematics because..." Bonnie instructs the person to switch chairs and sit in the chair appropriate to the feeling as the person talks. Eventually the person feels more comfortable in either the blue chair (taking math) or in the red chair (dropping math) and resolves the particular conflict.

² Heckerman, C.L. (Ed.). The Evolving Female: Psychosocial Perspectives. New York: Human Sciences Press, 1979 includes a more detailed description in "Math Anxiety and Female Mental Health."

Psychological Homework

After the first meeting Bonnie or I explain psychological homework to the members. This term encompasses the techniques described above--awareness (monitoring thoughts, physical responses, inner messages), relaxation exercises, and the math diary and noting self-defeating thoughts or attitudes. Homework means that they must practice and rehearse the techniques between meetings. They also have to practice recognizing and acknowledging that there is some math that they can do.

Bonnie instructs members in the use of all these various strategies, well aware that participants will be attracted to some exercises and resistive to others. We accept this resistance and offer the widest variety of techniques in order to encourage individual selection of the most appropriate method. All the exercises heighten the participants' awareness of the intensity of their feelings.

As the workshop progresses and members begin to change their old patterns we indicate to them how they are changing and urge them to take credit for their successful math experiences. Also they reassure one another. This mutuality deepens the sense of community established in the beginning session.

Summary

A typical series of six sessions would begin with the establishment of a safe and trusting atmosphere and the sharing of math autobiographies. Before the end of the first evening, psychological homework and the math diary would be explained. All following sessions begin with unfinished issues from the previous session and sharing of experiences from the week past. In sessions two, three, and four, the Gestalt exercises are integrated with some mathematics teaching so that participants can uncover and re-experience their own personal stress reaction to their math anxiety. In sessions four and five mathematics becomes a more central focus. Sometimes we simulate a math class in session five. However, at any point in the mathematics learning the counselor may interrupt the "math lesson" in order to discuss with participants how they are treating themselves. In the final session of the series of six, the group articulates its sense of accomplishment and its power over the learning of math with a discussion of future mathematical plans.

Dispelling The Mathematical Mystique--Role of the Math Instructor

Susan, the mathematician and co-leader of this group, may be the first mathematician that the participants have met since leaving school. Thus, she has an important role to play as dispeller of myths about mathematics. Many math anxious people see mathematics as strict, unemotional, and specific at all stages. They believe that speed is crucial and that it is important to do mental arithmetic. They are fearful of making mistakes and do not believe that mistakes can be "fixed" or learned from.

Their feelings about mathematicians correspond to their feelings about mathematics. The mathematician is imagined to be a cold, uninteresting,

rigid, rational, uncreative, and insensitive man who works only with "facts and figures"; very much as W.W. Sawyer³ wrote in 1943:

Many people regard mathematicians as a race apart, possessed of almost supernatural powers. While this is very flattering for successful mathematicians, it is very bad for those who for one reason or another, are attempting to learn the subject.

Susan takes care to explain how language is used in mathematics. She explains that one must disregard prior associations and definitions of many otherwise commonly used symbols and words. For example, an exclamation point (!) in English signifies that something is astonishing whereas in mathematics it is a shorthand notation used to denote a particular type of multiplication.

Susan's presence frequently stimulates two responses that are mutually contradictory and unrealistic. At the outset, she may engender the same hostility and fear that other mathematics instructors have caused the participants to feel. Later, after some successful learning takes place she may be empowered by the learners with "magical" qualities, and the participants may convince themselves that they can learn mathematics only from her.

One way Susan helps dispel the participants' misunderstanding of how mathematics is done is by talking frankly about the way she handles mathematics problems. She explains that she too experiences frustration and even anxiety in mathematical problem solving. But one of the pleasures of mathematical problem solving for her is that the problem doesn't change over time; she can take a break and come back to solve it. She tells the participants that sometimes she even solves a problem unconsciously while asleep or during a flash of insight while engaged in another activity. We talk about the qualities of temperament such as perseverance, patience, feelings of challenge, focusing on detail, and precision that are necessary in mathematics.

The math anxious person has often expressed that he/she feels out of control when confronting a mathematical problem. We explain that one must be willing to risk a wrong answer or risk going in the wrong direction when first beginning to solve a problem so that fear of being wrong doesn't stop one from getting started. Susan admits to the participants that she too experiences feelings of floundering, groping, and grappling when first trying to solve a mathematical problem. One strategy that Susan uses as a beginning step to help her gain control of a mathematical problem is to list what information the problem gives her and what other information she needs to know. Sometimes there is another question (possibly an easier one) to an answer that will pave the way to answering the problem. When this is the case Susan would first pose the alternative question and answer it before answering the original question.

Susan talks about other strategies she uses in problem solving. She explains that she uses her intuition, makes some conjectures, and estimates. She draws some pictures, looks for patterns, and sees if her answers are reasonable. These are some of the strategies used by mathematicians to get a

³ W.W. Sawyer, A Mathematician's Delight, New York: Penguin, 1943.

handle on a mathematical problem. We mention these strategies many times to the participants. We remind the participants that mathematics is not a quick and easy subject to understand. It takes time to feel comfortable and familiar with the specific subject matter, its language, and its symbolism.

Interaction Between Counselor and Math Instructor

During the math anxiety workshop meetings we watch each other closely and communicate nonverbally through eye contact, body language and facial expression. Sometimes one of us is the primary leader and sometimes we both share leading the discussion.

One of our strengths has been our ability to follow the interests and needs of the group. We carefully prepare a plan for a session, but if we find that the participants have different needs we can take the group in another direction. We may, for example, be focusing on a mathematical idea and realize that one or several members have become bored, fatigued or frustrated. The counselor will interrupt the explanation and ask the members to examine their feelings. Sometimes we divide the group into pairs to examine their responses and they share these responses with the entire group. This type of interruption or change in direction is important in the workshop, and the co-leaders must trust one another to make the shift when necessary.

Between sessions the two of us discuss what has gone on in the group including group dynamics, the characteristics and needs of particular members and the interplay between us. We then decide what to do next. If we have taped the group session we can replay the interactions between the members and ourselves as we make these decisions.

In a different type of workshop--one that combines mathematical instruction with math anxiety reduction--Susan may teach the participants some of the math that they need in their business life. If we hope to include some specific math learning, we either lengthen the workshop to ten or fourteen weeks (similar to a course) or meet intensively for two and one half or three days. The advantage of the intensive format is that a special camaraderie develops which facilitates the learning of mathematics. Participants who share a special part of their past during the intensive workshop rapidly develop the freedom to ask questions in front of others. Their tendency to drift is controlled by Bonnie's presence. She gives the participants insights into their avoidance behaviors and they concentrate more fully on the mathematics instruction.

We try to be aware of and avoid any tendencies in ourselves to become saviors. Typically, when a particular piece of mathematics is not understood a math instructor's first response might be, "I can teach you how to solve this problem." Susan, cooperating with Bonnie, does not fall into this role. In the math anxiety workshop our message to participants is that we can only facilitate their change. The math anxious can and must change themselves.

PROMOTING THE PARTICIPATION OF WOMEN IN THE SCIENCES

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Children as young as six years old have definite ideas about the kind of work that men and women do. They know that mothers are teachers, nurses, and secretaries, and that fathers are everything else. The extremely narrow range of careers that little girls--and young women--envision for themselves becomes a reality when they grow up.

Women who work full-time in 1979 are concentrated in clerical, service, and teaching occupations. And they earn 60% of men's salaries. Despite the bleak employment outlook for teachers, which is expected to remain so in the next decade, the majority of college women are still majoring in education. On the other hand, the demand for engineers and computer scientists far outstrips supply.

The educational and social patterns of our society have designated fields in mathematics, science, and technology as "masculine." The underrepresentation of women in these fields is a reflection of how we educate our children. When they graduate from high school, college-bound females have significantly fewer years of study of math and physical science than their male peers. The effect of this math and science avoidance is to disqualify young women from preparing for a scientific or technical career. For example, only 2% of the working engineers are women; 9% of the mathematicians; and 11% of the chemists; but 99% of all clerical positions are held by women. Whether or not they are college educated, women work in an extremely narrow range of occupations that, for the most part, do not require math or science training.

Since 1974, Lawrence Hall of Science has been developing programs, materials, and teaching strategies to promote the participation of girls and women in math and science, and to encourage their entry into nontraditional occupations. A career is considered nontraditional for women if less than 25% of the workers in that field are female. Our efforts have been directed toward students of all ages, in all settings, and has led to the establishment of a network of 500 scientists, educators, engineers, and community people from school districts, colleges and universities, government, and industry.

We have seen how a center can take a leadership role in developing access to science for underrepresented groups. Both Lawrence Hall and the public we serve have benefited from our involvement in this effort. We've learned a great deal while discovering how much more needs to be done.

Why Women Avoid Math and Science

Our attention was first directed to the underrepresentation of women in science by a study conducted by Lucy Sells in 1973 on the Berkeley campus. She found wide discrepancies in the math and science preparation

of first-year men and women students at the University of California. In particular, significantly more men than women students were entering Cal with three or more years of high school math--the prerequisite for the calculus sequence required for 63 of the 112 undergraduate majors. The 49 majors that do not require calculus are in the arts and humanities, education, foreign languages, and physical education. None of these fields offer good employment prospects. Hence, women students were making decisions during high school that were effectively closing off their options to studies in all of the physical, life, and social sciences, as well as business, engineering, and mathematics.

As part of Lawrence Hall's program to increase public understanding and enjoyment of science, we offer after-school classes for children, ages 6-18, in the physical and life sciences, mathematics, and computer science. In 1974, we surveyed these classes and found that female students accounted for less than 25% of the enrollment. We reasoned that, if female attrition in the sciences begins as early as age 6, it is not surprising to find less than 2% of them as engineers 16 years later. Clearly, something needed to be done to understand why girls and women were avoiding math and science.

Several studies have examined the reasons for the difference in math and science participation among young men and women (Casserly, 1975; Fennema and Sherman, 1978; Fox, 1978; Haven, 1972; Kirk, 1975; Levine, 1976). It appears that young women have a variety of negative attitudes toward these subjects. These include a general lack of interest in math; a lack of confidence in their ability to do well in mathematics; an inability to see the relevance of math to their present or future interests; and a belief that math is a generally inappropriate pursuit for females, or that others will view it as such.

How do these attitudes develop? What factors have influenced young women who choose to pursue math and science throughout their educational careers? Researchers point to parents, teachers, counselors, and peers as influential in the decisions, activities, and views of these women (Casserly, 1975; Haven, 1972). These attitudes may be influenced by the kinds of activities and games provided by parents. Astin (1974) found, among a small sample of parents of gifted children, that boys were more likely to receive science kits, microscopes or telescopes than girls. In a Lawrence Hall study, Sneider (1979) found in a sample of 138 high school students that 44% of the girls, but only 23% of the boys, reported that they had never before used a telescope. Kirk (1975) found, among high-ability young women, that those who were "science-bound" were significantly more interested in puzzles and problem solving than were those who were not science-bound. This failure to stimulate inquiry and investigation may restrict early curiosity in problem solving and risk taking, so essential to the development of mathematical and scientific interests and abilities.

Teachers, counselors, and peers often perpetuate stereotypic beliefs that women don't need to study math, that boys are better than girls at math, and that women couldn't or shouldn't become scientists or technicians. Ernest (1975) found nearly half of the elementary and secondary school teachers he questioned were convinced that boys are better at math than girls. Many of the talented high school women studied by Casserly (1975) reported having been discouraged from enrolling in advanced science and math courses by their guidance counselors. In some instances the counselors felt

that advanced math wasn't necessary for college; in others, that it was superfluous for girls, perhaps even damaging if it could in any way lower their grade point average.

Math for Girls

In response to some of these factors, we established our first "Math for Girls" class five years ago to attract girls to Lawrence Hall. Our enrollment continues to be drawn from girls, ages 6-12, with varying backgrounds and interests, who come once a week for eight weeks.

Math for Girls is taught by women students at the University of California, Berkeley, who are majoring in mathematics, mathematics education, or computer science. They are selected and trained on the basis of their interest and ability in mathematics, and their desire to act as role models for their students. Throughout the eight weeks, time is set aside for discussion of girls' competency and interest in mathematics, and the stereotypic attitudes that can result in limited career expectations for women. The importance of electing science and mathematics courses in high school is stressed.

The curriculum focuses on problem solving. Puzzles, games, and activities are used to show a side of mathematics that is as fun as it is challenging. Students are helped to look for fundamental concepts and relationships in mathematics, such as numerical and geometric patterns; understanding variables and functions; strategically organizing information; classifying into sets; using coordinate systems and graphing; estimating; and visualizing spatial relationships. Students are encouraged to generate a variety of ideas and are helped to concentrate on those that are most useful.

Since Spring 1974, 700 girls have taken the course and the total number of females enrolling in other Lawrence Hall classes has doubled. The program is spreading throughout the country through adaptation in community programs, science centers, and classrooms. We are producing a handbook, which will be available in September, that details the curriculum and will help others to replicate or adapt the course to local needs. The Math for Girls classes represented our first effort to provide positive experiences in mathematics for young women, but it only reaches a limited number of girls, primarily those who can afford the tuition.

Conferences

"Expanding Your Horizons in Science and Mathematics"--conferences for 7th-through 12th-grade women--was our next effort. Sponsored by Lawrence Hall in cooperation with educators from secondary and postsecondary institutions, as well as women working in nontraditional scientific and technical careers in corporations and government, we have had 20 conferences, serving 7,000 young women, their parents, and teachers since 1976.

The 7th- through 12th-grade students who attend these conferences, which are held on local college or university campuses, are recruited by their high school math and science teachers, parents, or other school personnel. The format of the conferences includes a morning panel in which women in a variety of math-based jobs, such as engineer, biologist, mathematician,

and electrician's apprentice, describe the challenges and problems of their work, from a very personal perspective. Following the panel, students attend math and science workshops that emphasize active participation and experimentation. There are activities in topology, probability, estimating, and statistics, as well as marine biology, astronomy, computer science, and engineering. After lunch, students attend small-group discussions in which they are able to meet with women working in scientific or other nontraditional fields. Here they have an opportunity to talk to the working women about their day-to-day experiences, plans for the future, and other important questions they may have.

While the students are in these workshops, special sessions are held for parents and teachers who have accompanied the girls. These focus on discussions of the history of women in science, media presentations of images of males and females in elementary school textbooks, analyses of programs to reduce sex stereotyping and increase career options for young women, and information about entrance requirements and financial aid to various local colleges, universities, and technical schools. The inclusion of the workshops for adults enables them to acquire practical information to help them assist their daughters and students in pursuing math and science interests. It also eliminates adult interference in student sessions.

The conferences serve to reinforce decisions that many of these young women have made to pursue a career in science. In their evaluations, the students remark on the importance of women role models and the diversity of career information they received at the conference. Several comments reflect this:

It felt good to see and hear from women who are into math and science who enjoy their work and are supportive of women entering those fields.

It was very good for me to see so many professional women in what I usually think of as careers that are totally male. It changes my opinion of that career at a much deeper level than if someone had just said to me, "Yes, it is possible for women to go into that field." To see is to believe.

One of the important spinoffs of these conferences has been the establishment of the Math/Science Network--an organization of 500 educators, scientists, and community people who work together to produce these annual conferences. The strength of their commitment is demonstrated by the fact that we were able to hold seven conferences on one day this year--from Sacramento to Los Angeles--and over 1,000 people contributed their time to ensure the success of these events. The Network is coordinated through the Lawrence Hall of Science and Mills College in Oakland and is supported by a grant from the Carnegie Corporation of New York.

Teacher Education

While the conferences reach many more people than Math for Girls classes, they are annual events, and their impact cannot be sustained without the longer-term support of parents and teachers. Thus, it was natural that we would expand our services to assist elementary and secondary educators in

adopting materials and strategies to attract and retain women students in math and science.

Our teacher training program, called EQUALS, is funded by the U.S. Office of Education, Title IV, and serves 100 K-12 teachers in Northern California. The program provides four days of in-service and leadership training designed to:

- 1) help educators examine their expectations of girls and boys in math and science;
- 2) assist them in developing and adapting materials to increase math comprehension among all their students; and
- 3) encourage them to develop strategies for incorporating career awareness into math and science courses and increase their awareness of opportunities available in math and science fields.

The major objective is to ensure that all materials presented can be easily transported back to the classroom and that participants are comfortable enough with the activities to recommend them to colleagues.

One aspect of the training that has proven extremely effective is to involve the teachers in a research project, studying their own students. Just as Lawrence Hall needed to examine its enrollment in after-school classes before we were convinced that we needed a Math for Girls class, we wanted the EQUALS teachers to look closely at their own school to see what the problems were.

We felt it was imperative to involve the EQUALS participants in a research project of their own which would familiarize them with some of the substantive issues in the research; help them clarify what the research means to them as educators, assist them in understanding different methods of analyzing data; and encourage them to use what they learned with their students and colleagues.

Consequently, in the letter that participants received accepting them into the EQUALS program a research project was enclosed. Participants were told to select one topic from the four that were offered and to conduct the study with as many students as possible. If they wished to do more than one, they were encouraged to do so, and many, in fact, did. The topics were selected to be appropriate at several grade levels, and instructions for collecting data were included. They were asked to bring a three-sentence summary of their findings, and all their data, to the first meeting.

The topics included a project to examine enrollments in all math classes in their schools and to report numbers and percents by subject and sex. Of the 100 EQUALS participants, approximately 25% chose this project, and their combined data gave us information on 18,000 students in 16 Bay Area high schools. Not unexpectedly, there were significant differences in male and female enrollments in the advanced math classes. In courses beyond Algebra II, there were 60% males and 40% females. In calculus classes alone, the ratio was 65% male and 35% female. Of the 229 students taking computer science in seven high schools 80% were males, 20% females. Those teachers

who also looked at the science and industrial arts enrollments in their schools found even wider discrepancies between male and female enrollments.

Another research topic that many participants chose focused on career aspirations. Participants were told to give the following statement to their students and to encourage them to write as much as they wanted on the subject: "Imagine you are 30 years old. Describe a typical day in your life." Participants were asked to tally the career choices mentioned by sex, and to note the number of traditional and nontraditional career choices mentioned by both boys and girls. The data collected from this research project represented 1,690 students, grades 4-12. Dramatic differences were found both in students' choice of occupations and the level of their aspirations. Boys expressed far more choices in their intended careers; girls, for the most part, indicated that they would be working in the traditionally female fields--teaching, nursing, secretarial services. Not surprisingly, girls devoted more time to describing their family responsibilities and showed an acute awareness of the realities of juggling work and home demands. Typical of many girls' responses was the following:

To start the day, I would get up at 6:00 in the morning. Making sure the kids were up and getting ready for school, I would stumble out into the kitchen to get a cup of coffee. After packing lunches I would get dressed and wake my husband up. At 6:45 I would leave the house to battle the traffic through town to work. After arriving at the hospital, I would go to work in the lab. After work, I would come home to a house full of kids and a mess to go with it. After an hour of cleaning up, I would start preparing dinner. After dinner, the kids and I would clean up, and from 8:00-10:00 we would all relax, maybe watch TV or do something we enjoy. After 10:00, I would go to bed only to wake up to the same rat-race in the morning. (16-year-old)

Here's a somewhat more positive view, with a traditional solution to one of life's problems:

A typical day in my life at 30 would start off with a good morning kiss from my husband, a peaceful breakfast, some exercising, a warm shower, and then off to work. I think I'd be a secretary. I'd work and make the best out of every day. People do have their up and downs, but I can get through mine and still come out smiling the next day. After work, I'd like to be able to relax for about an hour at the spa and come home and make dinner. Of course, with inflation and talk of a depression coming, our budget would be very tight. A secretary's salary may not be the best. But if I could, my husband would be a doctor or a lawyer, and then we'd be set. (16-year-old)

And, finally, a young woman with some very definite career goals:

A day in my life when I'm 30 will not be typical. I will be a marine biologist working on a private project with a grant from the government. I have gone to school and done well, because this is something I really care about. I will get up in the morning and be ready to leave my house by the ocean to start a new day in the ocean, studying the animal and plant life. I will scuba dive down to the ocean floor, underwater

caves, and maybe make some astounding discoveries. I may be married, may or may not have kids. That's too much to think about. (16-year-old)

Now, what about the young men in this sample? Most noticeably, their expectations for themselves are much higher. Many young men mentioned that they would be making a lot of money and have achieved a high status in their profession.

For example:

At the age of 30 I have made it to the top as an architect. I make about \$100,000 a year. Someday I hope to make more, but I will wait another five years. My houses are in the finest countries here on these united planets. My best business is here on planet Earth, but Pluto is close behind. I am still unmarried, but I have some live-in maids and female chauffeurs. (16-year-old)

Their view of family life is often not any more positive than the women students':

7:00 a.m. I'm up and eating breakfast with my family, 8:00 ready to go to work so I hop in my Porsche and go down to the shop where I fix the throttle on the car. That only takes a little while, then off to work where I spend most of the day on a new project for NASA medical research. I then arrive back home when my son says he bought a guitar, and my daughter says she needs to borrow the car. Being kind of tired, I say OK just to get them to stop fighting. I sit down at the dinner table and munch, when I get a phone call from the LA studios, reminding me of my appointment with them Thursday. All in all, a great day, but I'm glad it's over. (16-year-old)

EQUALS participants who chose this topic for their research project felt that it provided them with insights about their students that were, in many cases, both shocking and helpful. "I really thought I knew my kids," was a frequent comment, "but I guess I have a lot to learn."

The impact of the research project was to hook the teachers into the program. Each participant had become an "expert" about his/her own school, students, and data. Once the teachers had an investment in the issue, we were able to work together to identify problems within their schools and develop strategies to overcome them.

The remainder of the four-day training was devoted to furnishing participants materials and teaching strategies to broaden aspirations rather than reinforce stereotypes about the working world; nonsexist activities to promote educational opportunities for girls and boys to develop their full potential; and learning materials that stimulate student interest in math and science fields. In the area of mathematics education, we focused on word problems--an area of difficulty for all students, and a recurrent mathematics topic. Participants were given experience in teaching strategies that focused on helping students to take risks, eliminate possibilities, use models and develop their own hypotheses, break set and see patterns: problem solving strategies that encourage assertiveness, questioning, guessing, and tenacity -- traits that especially need strengthening in female students.

The impact of the EQUALS program has been evident in the number of in-service presentations that participants have arranged in their districts. Their requests for more information and materials to provide to their colleagues, as well as requests from school administrators for in-depth workshops for their staff, indicate that the program is spreading throughout Northern California. We have received requests from 45 districts in California to become part of our 1980 program; and if we receive funding, we will be able to service these people.

In the future, we expect to include vocational education instructors in our training programs. Forty-five percent of all female students enrolled in vocational education are taking homemaking courses, which is not preparing them for gainful employment. We need to open up options for these girls in the skilled trades and technical areas, by encouraging them to enroll in drafting, electronics, auto mechanics, and similar courses. We see our job as making sure their instructors understand the importance of preparing women students to be as skilled as the men students in areas of technology and the trades.

Working Women

Finally, we have not ignored the problems of women trained in the sciences. We know there has been an increase of women students in nontraditional fields, such as engineering and medicine, and there have been countless articles and books documenting the changing roles of men and women in our society. This kind of information might lead us to believe that women scientists are benefitting from the opening of opportunities to underrepresented groups. Unfortunately, this is not the case.

The April 1978 issue of Scientific, Engineering, and Technical Manpower Comments reports that:

Women trained in the sciences and engineering are experiencing underemployment rates three to five times higher than those of their male colleagues; women employed in scientific and technological careers earn less than men in every field, at every degree level, every experience level, and in every employment setting... We are so far from equal opportunity that even with a 10% improvement every year, it will be another 50 years before talented women have equal access to careers in engineering, physics, and chemistry." (p. 17)

Clearly, the educational, institutional, and cultural barriers that mitigated the participation of women in the sciences for decades have not fallen to any considerable degree. So, when we discuss efforts at the pre-college level to prevent the attrition of women students from the sciences, we must not ignore the difficulties faced by women who have surmounted these barriers and continue to struggle for equality of opportunity.

With a grant from the National Science Foundation (NSF), Lawrence Hall conducted a one-day conference for 350 women who had earned degrees in the physical, life, or social sciences but are currently underemployed or employed. The conference was designed to facilitate an information and resource exchange between these women and 65 women who had advanced their

careers in these fields. A follow-up study of underemployed women is being conducted to provide information to NSF about the impact of programs for postsecondary women. In addition, a booklet is being prepared aimed at assessing employment opportunities for women in the sciences and facilitating the mobility of women into management careers.

What started out as a modest program to encourage little girls to come to Lawrence Hall and enjoy mathematics has turned into a full-time operation that encompasses programs designed for students of all ages, teachers, and working women. The thread that runs through each of the programs and holds it together is the conviction that it's time to charge the current educational and societal patterns that confine women to a narrow range of occupations.

The Role of Science Centers

What we have learned from our work, and what is directly applicable to other museum educators, is the crucial role that a science center can take to facilitate the access of women to science. In 1978, 160 million visits were made to 773 science museums in this country, an average of 206,000 per museum mostly by family groups. What are they learning about the history and role of women in our society, and, in particular, about women in science? What is being done to ensure that mothers and daughters feel as much at home in a science center as their fathers and sons do? What, indeed, is the payoff to any institution to survey the needs and interests of its women visitors?

The science center can perform three critical functions relative to increasing access of underrepresented groups to the sciences. First, it can create an awareness of what is at issue. The public needs to understand that there is a problem when large numbers of people in our society are not acquiring scientific literacy or participating to any significant degree in scientific activities and achievements. In our experience, once people are informed about the problem concerning women and the sciences, a sizable number of them become interested in doing something about it.

Our Math for Girls class was extremely important in creating that awareness. We described the class in our newsletter and explained why we were offering it, and what we hoped to accomplish. It was of sufficient interest to both the local and national media that we received extensive publicity, which further increased public awareness. The publicity that the program received put us in contact with others who were working in this area, though not with students as young as ours. We were then able to develop a network of people who were working on this problem at all levels of education, as well as industry and government.

We had entered, by this time, a period of experimentation in which we were trying out a number of programs and strategies, and exchanging ideas with many people. And this is the second step. In a science center, experimentation is valued, risk-taking is encouraged, and we are able to develop good ideas and discard the ones that don't work. We can try and fail, and we have considerably more freedom to do both than many of our colleagues in formal educational settings. We will be in this period of experimentation for some time, because we need to know more about learning, motivation and communication.

Thirdly, the science center can become a magnet to attract talented people from many disciplines who are concerned with these issues. The infusion of ideas from those working outside of the educational system is particularly important. In our case, the contribution of women scientists and engineers was essential in mounting the large-scale effort required to develop our programs for junior high and high school students. We, in turn, were able to offer these women an opportunity to make contacts with women like themselves who were isolated from each other in their all-male work settings. In short, everybody wins when you enlarge your resource base and encourage new people to work with you. The visibility of the science center, with its close ties to the community, the schools, and industry, but its complete identification with none of these groups, makes it a particularly attractive setting in which people who normally do not have contact with each other can come together to share their knowledge and skills.

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A FLYING START AT OVERCOMING MATH ANXIETY

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I'm sure we are all aware that one of the reasons women and minorities are so under-represented in technical and scientific careers is that many of them lack the confidence to take more than the minimum required science and mathematics courses in high school or do not realize the importance of doing so. This conference is concerned with encouraging women and minority students to continue in mathematics and science through a variety of aerospace programs. I want to suggest that actual flight experience, even if only a few hours, is the greatest motivator for learning the necessary mathematics and science for all students who dream of flying, including the math-anxious and science-avoiders.

I am here to tell you a success story about a federally funded experiment in education that worked, a high school aeronautics course in the small rural community of Onalaska, Wisconsin, and particularly about the reaction of the girls who took the course.

Even in 1964, when over half the people in town had never been in an airplane, high school girls were eager to expand the traditional role of women to include aviation when the opportunity was offered by the school. A survey taken by the project planners before the course was started indicated the percentage of girls interested in taking aeronautics only slightly lower than boys, about 45% of both sophomore and junior classes at Onalaska. My research on students who took the course over a ten-year period indicates some of the dislike of mathematics and lack of confidence in their mathematical ability which one expects to find expressed by females more often than males, from 6th grade on. It also indicates that this can be overcome when mathematics becomes necessary for something the girls really want to do. The instructors reported no sex-related differences in academic achievement in the course. The trophy for best student offered by a local flying club was won 2 out of 5 times by girls.

My experience with older ground school students at Madison Area Technical College has been similar. Of 240 students in the past three years, one fourth have been women. They are much more likely to tell me they "hate math" or "can't do math," and more frequently attend extra sessions on learning to use the flight computer. But, by the end of the sixty hour course, their performance on navigation problems, weight and balance problems, interpreting performance charts, multi-step computations of fuel consumed, etc. does not differ significantly from males.

First let's take a look at how students responding to a follow-up survey on the Onalaska Aeronautics Course feel it affected their lives and then, more specifically, at the sex-related data.

SUMMARY OF REPORT OF ONALASKA AERONAUTICS PROJECT SURVEY

I. HISTORY OF THE ONALASKA AERONAUTICS COURSE

The aeronautics course began in 1966 as a federally funded experiment to explore the possibilities of: 1) involving the local aviation community in providing career-exploratory experiences, and 2) including enough flight instruction to enable students to decide about their aptitude for flying and to serve as a demonstration of physical principles learned in the classroom. This aerial laboratory experience, rather than flight instruction, has been emphasized since the purchase of a Cessna 172 "Flying Laboratory" by the Cooperative Education Service Area #11 in LaCrosse. Flight time decreased from 10 hours in the first years to about 3. One year there was none.

Only two instructors, with very similar aims, have taught the course since its beginning. While additional activities such as a kite-making contest have been added, the academic content of the course has not changed. Information on careers is still presented through field trips and a Career Day at LaCrosse Airport for all aerospace classes in the area. Onalaska has had a long and consistent experience with one of the many approaches to aerospace education currently being considered by other high schools.

Students' evaluations at the end of the aeronautics course and on a follow-up study done in 1969 at the end of the federal project were very favorable. Parents enjoyed being taken for an airplane ride by their own son or daughter and seeing the increased self-confidence, safety-consciousness and application to studies which often accompanied taking the aeronautics course. Community support is evidenced by the fact that the course has continued long after the cessation of federal funds.

II. DESIGN OF THIS STUDY

The questions to be investigated were:

1. How well do students feel the course objectives were met?
2. What were students' reasons for taking the course and how well were their own objectives met?
3. What effects did any aspect of the aeronautics course have on school and career decisions or on students' lives since graduation?
4. Are there any significant differences of opinion about the course related to the students' occupation, sex, amount of education beyond high school, or reasons for taking the aeronautics course?
5. Do evaluations vary with a change of instructor or number of flight hours offered each year?
6. How do the opinions of students who graduated from high school 8-10 years ago compare with their end-of-course evaluations and opinions on the 1969 follow-up study?

7. What reasons are given for not supporting a similar course as taxpayers and is there anything characteristically different about the non-supporters' experience with the course or after graduation?

Question 4 was included because a frequent criticism of aeronautics courses is that they are primarily vocational training, of value only to the few students who become pilots or pursue a career related to aviation, and not useful as college preparation. Sex was included as a variable because aviation has been predominantly a male field. Only 5% of pilots nationally and in Wisconsin are female.

III. RESULTS

One cannot generalize from this non-random sample of 160 students to the population of some 500 students who took the aeronautics course in 1966-76, but the sample is similar to the original class lists in several respects; i.e. percent of female (34%) and percent of students who took the course during the period of federal funding (1966-69) versus 1970-76, about half in each period. At least 13% of each class responded to the questionnaire. There is no reason to believe the sample is biased in any way except that, as with any mail survey, it is usually the people with strong or favorable opinions who respond.

Ninety percent of responses were from people not employed in the field of aviation, mainly college students and business or professional people. 38% respondents are college graduates, 47% had 1-3 years of college, 15% no formal education beyond high school. Average education beyond high school was 2.6 years, with no significant difference between males and females.

The largest category who obviously made some use of the aeronautics course is the 22% depicted in Figure 1 who either had some further flight training or are employed in the field of aviation. Ten percent of students have pilot certificates.

FIGURE 1

Frequency of Students employed in aerospace(A) or having further flight training(B).

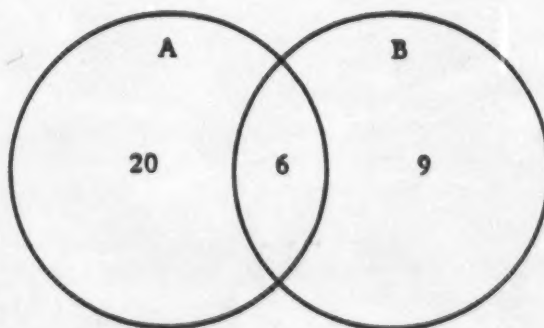
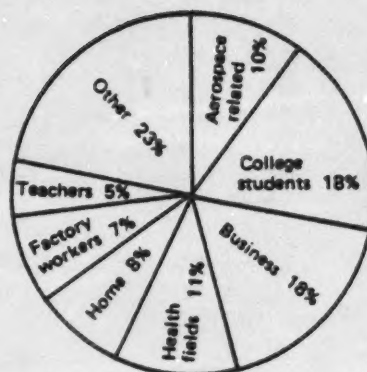


FIGURE 2

Occupations of people responding to survey

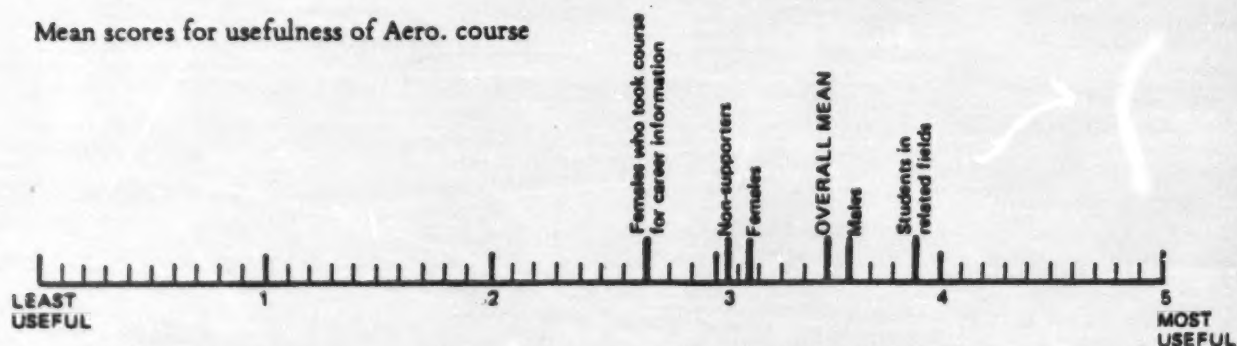


A. General Evaluation of Aeronautics Course

Although most students are not pilots or employed in the field of aviation, 87% indicated they would support a similar aeronautics course as taxpayers. They rated the aeronautics course highly interesting compared with other high school courses (a mean score of 4.5 on a scale of 5, with standard deviation of .7). The overall mean score for usefulness (3.4 on a scale of 5) was well below the mean for interest, but still indicates an above average rating. Opinions about the usefulness of the course differed more than about its high interest. Predictably, students in related occupations rated the usefulness of the course higher. Females found the course slightly less useful than males but still above average compared with other high school courses, except for the 9 females whose main reason for taking the course was for career information (mean score 2.67). Students who would not support a similar aeronautics course as taxpayers also rated usefulness significantly lower (3.05) but interest as high as other students.

FIGURE 3

Mean scores for usefulness of Aero. course



Most students took the aeronautics course because of a desire to fly and found the flight time the most beneficial part of the course as well as the most enjoyable. The science content of the course was rated most beneficial by a much higher percentage of students who did not go on to college than by those who did.

The study of aircraft engines and the mathematics involved in the course were rated the most difficult and least enjoyable of the subject matter. A higher proportion of females than males rate mathematics least enjoyable, except for females who took the course mainly for the science content.

B. How Well Were Course Objectives Met?

1. Information for career decisions.

Very few students rated career information the most beneficial aspect of the course. One-fourth of students did say their decision to seek employment in the aerospace industry was influenced by the course and 31% said the course influenced them to seek further training in aviation. Scores on how well their own objectives were met were significantly lower for students who took the course primarily for career information than for those who took it for other reasons. However, only 8% of students indicated they took the course for career information primarily. Mean score for how well the aeronautics course acquainted them with job possibilities in the aerospace industry was 3.37 on a 5 point scale. There were many comments suggesting more specific job information as an improvement in the course.

2. Flight time to determine aptitude for flying.

Sixty-nine percent of students replied that they had had enough flight time to decide about further flight training. Twenty-six percent of males and 40% of females said they had not. This did not vary significantly by year, except for the year in which no flight time was offered.

3. Stimulation of interest in science and mathematics.

Science content was rated the most beneficial aspect of the course by 30% of students. Twenty-seven percent of students said their interest in other courses was stimulated.

Physics	46%
Mathematics	30%
Geography	20%
Meteorology	4%

Sixteen percent said the aeronautics course influenced them to continue their education beyond high school and affected their choice of a major field of study.

4. Change of attitudes toward aviation.

Students were asked whether the course had changed their attitudes toward the safety of air transportation, the importance of the airport to the local community and the place of the aerospace industry in the national economy. Seventy to seventy-six percent responded yes to each of those questions. Changes toward the role of women

and minorities in aviation were not specific objectives of the course, but might have resulted from study of the career information and from the opportunity for all students to try flying. Higher percentages of females than males reported attitude changes toward the role of women in aviation, air safety, and job possibilities.

C. How Well Were Students' Personal Objectives Met?

The mean score for how well their own objectives were met was 4.1 on a five-point scale.

Since most students' main objective was to try flying, it is not surprising that 77% rated flight time the most enjoyable aspect of the course. More surprising perhaps is the fact that, although it accounted for only a few hours of each semester's work, 61% of students looking back on the course as much as 10 years later rate flying the most beneficial aspect. This seems to support the idea that, whether or not one becomes a pilot, flying a plane can be a valuable educational experience.

D. Effects of the Aeronautics Course

Ten percent of students are employed in careers related to aviation. Twenty-eight students, 3 of them female, took further flight training, and 14 hope to do so when it becomes financially possible. Sixteen students attained pilot certificates; 10 private pilot, 1 commercial, 1 CFI, 4 student pilot. Five students own aircraft and 6 charter aircraft for business purposes. Twenty students fly for business, 16 for family or personal transportation, 10 mainly for pleasure. Nearly half of students say they have influenced someone else's decision to learn to fly. Comments indicate that most students would not have tried flying if the opportunity had not been offered through high school.

Sixty-eight percent of students read more about aviation and space topics as a result of taking the aeronautics course, and comments indicate a continuing lively interest in the subject. Sixty-two percent have encouraged others to take the course at Onalaska and one-third feel they have influenced others to consider careers in aerospace.

Comments about effects of the course center around general scientific knowledge, enjoyment of leisure, and increased self-confidence from having met the challenge of actual flying. A few typical comments are:

- ° The course has enabled me to fly without fear and also to form better opinions on what legislation should or shouldn't be supported concerning aviation and space programs in the making.
- ° This course offered a wide variety of general knowledge, such as basic weather, radio, electronics, etc. that have been useful in other courses I've taken in high school and college.
- ° This course provides information which is useful to almost everybody in today's society. Even if you never fly again, the meteorology training is very useful.

- ° ...efficiency, care to find things in their proper place, a logical order of events.
- ° ...more safety-conscious.
- ° I found that the whole experience made me a much more self-assured and outgoing person.
- ° The experience of flying is something everyone should have.
- ° As a woman I feel that if possible every woman should have an opportunity to learn more of aerospace! ...have enjoyed my experiences and shared with others. The course was excellent, the instructors fantastic!
- ° The course at Onalaska exposed me, as well as several other females, to the aviation industry in a role other than stewardess. I probably would not have had the opportunity otherwise.
- ° It gave people a chance of a lifetime for free flying lessons and a chance to discover aviation careers that they didn't know existed.

E. Differences of Opinion Related to Occupation,
Sex, Amount of Education Beyond High School,
Reasons for Taking the Course or Year Course was Taken

Differences by year, which might have reflected differences in number of flight hours or instructor, were negligible.

A higher percentage of students in related occupations had taken further flight training, found career information useful, and had influenced others to fly; but all other responses were similar to those of students in other occupations.

The only significant difference between responses on 1966-69 students and those who took the course in 1970-76 was that 82% of the earlier graduates would support a similar course as taxpayers and 91% of the more recent graduates.

End-of-course evaluations for students who took the course in 1966-69 showed 59% interested in additional flight instruction and 34% interested in employment in the field. Forty percent said the course had influenced their vocational interests. Of 1966-69 students responding to the 1977 survey, 18% took further flight instruction and 15% volunteered that the expense was prohibitive. Only 8% are employed in the aviation field. In spite of the fact that many students' hopes for further flight instruction or employment in the aerospace field were not fulfilled, opinions of the interest and value of the aeronautics course have remained high.

Since only 5% of pilots in the United States and in Wisconsin are female, one might expect that an aeronautics course would not attract many girls or that those who took it might not find it as interesting or useful as the males. Actually, about one-third of the students who took the course each year were female and this is reflected in the percentage of female responses to the survey (1966-69, 35%; 1970-76, 32%). The similarities in male and female opinions are more striking than the differences. Females rated this course as interesting as the males did. Most of them took the course because of a desire to fly, as did males; and listed flying as the most enjoyable and beneficial part of the course. A significantly higher percent of females (92% versus 84% of males) indicate support for an aeronautics course as taxpayers.

There were significant differences between males and females in reasons for taking the course other than flying. Females were more interested in career information and less in the science content. The 9 females who took the course mainly for career information rated usefulness 2.7 on a 5 point scale, lower than any other group.

Table 1					
Reasons for Taking Course Percent of Responses					
		<u>Career Information</u>	<u>Science</u>	<u>Desire to Fly</u>	<u>Other</u>
M	N				
	107	3	24	72	1
F	53	18	10	69	2
Total	160	8	20	71	1

The mean of female ratings of usefulness of the course was 3.16 on a 5 point scale and the mean of male responses, 3.58. The two means indicate, however, that both males and females rated the aeronautics course slightly more useful than their average high school course. They enjoyed flying as much, but very few took any further flight training or found employment in the aviation field.

Table 2			
FREQUENCIES OF AVIATION RELATED- OCCUPATION OR PILOT CERTIFICATE BY SEX			
	<u>Male</u>	<u>Female</u>	<u>Total</u>
Related Occupation	12	3	15
Pilot Certificate	15	1	16
TOTAL	27	4	31

Comments about the usefulness of anything learned in aeronautics fell into the following categories in about equal proportions for males and females.

<u>Table 3</u> Comments on Usefulness % of responses in 4 main categories					
	<u>No comment</u>	<u>On the job</u>	<u>In other course</u>	<u>Leisure</u>	<u>General Knowledge</u>
MALE	56	15	5	10	16
FEMALE	62	12	4	12	10

Females reported a change of attitude about all the facets of aerospace more often than males, significantly so about the role of women in aviation, job possibilities, and air safety.

There were also sex-related differences in ranking various aspects of the course for difficulty. Males ranked Air Traffic Control procedures and communications, weather and flight technique more difficult than females did. Mathematics ranks had the highest variance for both males and females. Females gave mathematics a higher rank for difficulty than males. They also ranked aerodynamics and aircraft engine more difficult than males did. Females mentioned mathematics as the least enjoyable part of the course more often than males, except for the category of females whose main reason for taking the course was scientific curiosity.

<u>Table 4</u> Percent of Ss Rating Mathematics as the Least Enjoyable Part of Course by Sex and Reason for Taking Course						
	SCIENCE		FLYING		CAREER INFORMATION	
	N	%	N	%	N	%
MALE	23	4.3	68	7.5	3	0
FEMALE	5	0	34	17.6	9	11
TOTAL	28	3.6	102	10.9	12	8.3

Forty percent of females and only 26% of males said they had not had enough flight time to decide about their aptitude for flying. Very few females took further flight instruction or became pilots.

	Male	Female
Further flight instruction	23%	8%
Pilot certificates	15%	2%

Excerpts from several typical comments by women:

- ° As a woman, I feel that if possible, every woman should have an opportunity to learn more of aerospace! I have enjoyed my experiences and shared with others. The course was excellent, the instructors fantastic!
- ° It is a tough course, but interesting and fun!
- ° I haven't used my training in very many ways yet because of lack of funds.
- ° I feel that the course should be taught in every high school....it would give every student a better perspective of the world around him.
- ° So many things in school seem repetitious. This course provided me with all new information. It left a strong impression on me.
- ° When my sister took it in 1966, she received 10 hours of flight instruction and I wish I had had the chance to get the same.
- ° It gave people a chance of a lifetime for free flying lessons and a chance to discover aviation careers that they didn't know existed.
- ° Flying was exciting and challenging.
- ° I looked into Aeronautics at a college of my choice, but they didn't have facilities for women.

SUMMARY AND CONCLUSIONS

Compared to other high school courses, the aeronautics course was rated very interesting and above average in usefulness, which would be surprising if it were of value only to the few who became pilots or entered careers in the field of aerospace.

Course objectives and students' reasons for taking the course overlapped but did not completely coincide. Career information and flight experience for the purpose of deciding about a career were not prime

objectives for most students, nor was learning the science content, although one-third of students found science the most beneficial part of the course and one-fourth said career decisions were influenced. Most students seem to have simply wanted the fun and challenge of being at the controls of an airplane. They also view it as a practical application of classroom science and mathematics to warrant supporting such a course as taxpayers.

The course did well at providing information that would change attitudes toward aerospace and the opportunities it offers, especially for females. Many students found the general knowledge acquired to be valuable and have maintained a lively interest in the field.

Success in presenting career information was rated average. The objective of stimulating interest in science and math courses was achieved for one-fourth of the students. (It is difficult to judge what sort of percentages to look for in that area. When one encounters students who say they did not drop out of school, studied science or mathematics with renewed interest or went on to college specifically because of this course, perhaps one stops talking about percentages.)

Criticisms of the course reflect that instructional techniques and attitude toward students are important even in such an unusual and high interest course, especially for the flight instructor, who must help students overcome fear.

The mean score for how well students' own objectives were met was 4 on a 5 point scale. On the basis of student responses to the questions related to various course objectives the instructors and the researcher agree that course objectives were also very well met.

The frequent use of words like "refreshing, challenging, exciting and unique" in students' comments indicates the motivating power of aeronautics and the "hands on" experience of flying.

It is my opinion, based on this study, that, although most of the subject matter of aeronautics is drawn from the established disciplines of physics, mathematics and meteorology, there would be no point in such an interdisciplinary course without the unifying and motivating effect of actual flight experience. The flight time need not be justified as career exploration, although for some students it was indeed the beginning of a career, but as a memorable educational experience in itself.

This study indicates that the Onalaska Aeronautics Course is a success with students largely because it includes the fun of flying. To survive so long and expand throughout the district, it also had to be a success with school administrators. I would like to suggest that the success is due in part to the avoidance of three of aerospace education's pitfalls:

- 1) a narrow view of the subject which fails to deal with the impact of aviation and space technology in society
- 2) instructional materials or teacher attitude which discourage women and minority students from aspiring to some aerospace careers

3) overdependence on military, industrial or governmental agencies.

It is time for educators within the school system to take a more active part in setting the goals and planning the materials and programs of aerospace education if more success stories like Onalaska's are to be repeated throughout the nation.

One result, which mathematics educators would heartily approve, might well be "a flying start at overcoming math anxiety."

BASIC AERONAUTICS FOR GIRLS AND MINORITY STUDENTS
IN A "DO IT YOURSELF" CURRICULUM

Lt. Ruth West
A.E. Officer

Sq. 1007 and Group 100 Pennsylvania Wing, Civil Air Patrol

Aerospace Education in Civil Air Patrol

How do you teach the difficult facts about flight, motors, weather, and navigation to girls and boys who have either a poor reading level or little background in science, mathematics and physics? How do you teach without a laboratory, science equipment and a regular classroom?

These are some of the questions the Civil Air Patrol (CAP) aerospace officer faces as she/he tries to help cadets from ages 13 to 18 achieve an understanding of aeronautics in a one night a week program.

This problem faces most squadrons including the one I entered three years ago. I had taught science for fifteen years in both junior and senior high schools. There I had fine equipment and all the supplies needed to have my students complete very sophisticated experiments. I also had every kind of audio-visual aid available for my use.

The CAP cadet program is manned by many pilots, adults with communications licenses, and others with a variety of skills. There are few professional teachers serving in squadrons. Their basic purpose in joining CAP is to carry out its primary mission of search and rescue for downed aircraft. The cadet program, which blossomed during World War II, wanted to make young people space minded and so it stepped into the role of aerospace educator. The textbook for all cadet achievements had been drawn from many sources including the Federal Aviation Administration handbooks, and, at that time in the nineteen forties and fifties, was readable and understood by boys ages 16 to 18. Then in the early sixties the CAP lowered its cadet age to 13, or seventh grade, and had also begun to accept girls. Its educator consultants recommended that it embark upon the current fad of "open classroom," and CAP adopted the following program:

1. Cadets were given a textbook, Our Aerospace World, one chapter of which is devoted to each of the following: history of aerospace, principles of flight, power for aircraft, weather, navigation, and rockets.
2. Cadets were told they would not be bored with lecture type classes; they could take their book home and read and study it there. Then when they announced they were ready, they could take an achievement test on that chapter.
3. At the end of each chapter, quiz questions helped them review. Ideally counsellors were to tutor them upon request, and after the test they were to have a de-briefing by a competent senior. If they failed the test, they could taken it again the next month.

Many cadets took the same test two or three times until they knew the questions they failed and had learned these answers.

4. Squadron meetings were totally activity oriented with drill periods, speakers, films, and model building. Most cadet programs prided themselves in being run by the cadet officers, eleventh and twelfth graders.
5. At any given time each squadron had cadets on six different aerospace topics so a general class was not very sensible.
6. If a lecture or class was attempted it was given in a hanger, church basement or borrowed classroom with no storage area. Visual aids were rarely available except a film projector.

Philosophy of the Open Classroom

An open classroom uses "go at your own speed" packets or learning centers, and it was the invention of the British during World War II. They found themselves in makeshift classrooms in estates, in church halls etc. with students who had been evacuated from large cities. They had to operate in the most unconventional modes, and so was born the project centered unit in a learning center geared to take students through subject matter at their own progression and speed. In this type of classroom the teacher becomes a manager. Questions, reviews, self-tests and all directions usually given by a teacher are built into the packets. Much use is also made of audio cassettes to help students learn rather than use all reading materials.

CAP failed in its effort to get cadets to master aeronautical subject material because it did not want to "teach." This word was associated with a typical classroom teacher or lecturer at a blackboard. Unfortunately, like many school systems that also failed in this venture, they thought you could hand a traditional textbook with a sheet of few questions to a student and he could teach himself. As I wrote a curriculum for my junior high students in biology to be used in a "go at your own speed" type of open classroom, it became clear that I had to think ahead to every possible question they might raise, or to possible errors they would make in their progress. I then had to build into the packet of learning materials answers to their proposed questions and facts that would help them to spot an error and correct it. The teacher had to be built into the packet.

One great problem in my classroom and one encountered by the CAP cadet program was the student of low motivation. He/she could literally sit and do nothing unless there was some unusual kind of motivation in the materials. I found that use of games, models that could turn a flat page into a mobile, wheel or set of dominoes or puzzles for matching symbols and answers was the way to interest this student.

The CAP cadet program has lost ground in the past decade particularly in affluent communities. The low profile of the military and the lack of discipline in their lives often turns students away from our military program. It seems that families of middle class Americans from industrial areas are more drawn into our cadet program, along with the inner city

youngsters who do not have the many sports and extra curricular advantages offered by suburban schools.

Our Aerospace World textbook, in learning centers.

I have now taken the text and provided three or four short packets for each chapter which pick up key concepts to be learned. My goal is to have cadets pass the achievement tests they must take at the end of each chapter. I want them to pass because they know and understand this factual material. Therefore, I built the packets with this in mind:

1. Key concepts or ideas are cut to their essentials. They are the topics you would underline if reading the text.
2. Units are highly visual and cadets must make something out of a sheet of paper using scissors, rubber glue and felt markers.
3. For the squadron senior these "packets" become his lesson plan, the one he did not have time to prepare with the facts he may have forgotten.
4. The "packets" are in black and white, with line drawings and can be easily Xeroxed or copied.
5. Learning centers for experiments are placed in clear plastic blouse boxes, easily seen through with everything the cadet needs to complete his experiments. Directions and questions are given on 5" by 8" cards and immediate answers and results are found on the back of the card.
6. Airplane models or paper airplanes are used as a tool in themselves to teach design for flight and control surfaces.

Myth, you can't have fun while learning.

It is sad when an adult, usually a very bright pilot says let's not use the word "games" to describe your teaching aids. This person may be operating with a genius I.Q., be extremely high in reading level, and have the motivation of a man who can afford to take flying lessons so he eagerly studies for his ground school examinations. This is not the student we are trying to reach in the inner city who may be reading on a third grade level or who may be a girl who has never seen a motor or flown a model airplane.

The essence of excellent teaching is to test your materials and see how many senses they use. Not only the eye but the hand in tactile, manipulative activities are important but students must be able to build, take it home, hang it up or win a game. We know that coaches of team sports have no discipline problems and motivation is at a high pitch. This coach who may be successful on the field after school may be a dud in the conventional classroom.

Other uses for "packets" and "go at your own speed" units

In squadron meetings a film may not arrive for the night planned or the guest speaker, or senior teacher may be absent. These packets and games on the shelf can be used at a minute's notice and provide meaningful learning experiences as well as being different from the school day activities they have just completed.

We saw in the presentation of the Adler Planetarium Project that their public school systems provide pre-visit materials to complete, usually worksheets and projects before they come to the planetarium. Why not make these games, puzzles, etc. So too our National Air and Space Museum could send a Bingo type game to a prospective teacher or scout leader before visiting the museum. This game could include 25 objects in the museum and a fact or name associated with each one. Students could then look for these key exhibits as they roamed through museum areas. Puzzles could be developed with a missing phrase or word that would require students to read material on some specific displays and thus encourage them to see the best the museum offers. How many visitors run from one exhibit to the next? What do they absorb? Does your student know all the areas of interest at the NASM? Does he read the background materials written about the displays? How do you know? Games and some of these learning puzzles would make him become a participant in the museum rather than just an observer and this is the key to learning and the retention of information.

Finally, many teachers in the late elementary school grades or in junior and senior high schools may be venturing into aerospace education. If they are not pilots themselves it will be easier to get them to offer this new material if we can provide them with attractive, stimulating activities at low cost. Scout programs also can use these materials in their achievements. It is my hope that these packets, which offer a sound introduction to aeronautical subjects, may enable a teacher or a volunteer to offer our young people the challenge of flight or space in their own lives.

* * * * *

I would be happy to send examples of these "do it yourself" packets to teachers who want to try them out and would most appreciate any helpful suggestions or corrections they would care to make after using them. Please write to:

Lt. Ruth West
142 S. Gable Road
Paoli, PA 19301

WRAP-UP SESSION SUMMARY OF MULTI-CULTURAL CONFERENCE
June 11-12, 1979

Dr. Kerry M. Joels
Chief, Education Division
National Air & Space Museum
Washington, D. C.

The final activity of the multi-cultural conference was a wrap-up session. Brought together at this session were, Mr. Melvin B. Zisfein, Deputy Director of the National Air and Space Museum, Mr. Curtis Graves, Chief of the Education Community Services Branch of the National Aeronautics and Space Administration, Ms. Shiela Tobias, author of Overcoming Math Anxiety, Dr. Lonnie G. Bunch III, Assistant Professor of History, South-eastern Massachusetts University, and Dr. Kerry M. Joels, Chief, Education Division, National Air and Space Museum.

In introductory remarks to the session, Mr. Zisfein expressed his appreciation to the participants and introduced several of the guests attending the conference, including Dr. Herbert Thier of Lawrence Hall of Science, Berkeley, California, and Dr. Hollister Smith of the St. Louis Medical Museum.

Mr. Zisfein outlined the thinking and philosophy underlying the creation of the Museum and the continuing desire to be responsive to the needs of the entire community. Mr. Zisfein felt that the meeting itself and the wealth of experience of the participants have opened new horizons for the National Air and Space Museum. He also outlined several initiatives that the museum is pursuing.

The museum has always looked for new ways to serve the greater community. The conference added a variety of resources and inputs to our data base maintained for the purpose of increasing our multi-cultural offerings. Mr. Zisfein also referred to the senior fellows in the Museum Exhibit Operations Program, who will be documenting the exhibit procedures at the Museum and making them available to junior fellows. It is hoped that this program will enable our experience and capabilities in the exhibit process to be extended to others. This is just one example of how the lessons learned in the development and operation of the Museum can have a wider impact.

Dr. Joels then outlined some of the existing programs at the National Air & Space Museum (NASM) for multi-cultural education. These were held for discussion until the end of the conference so that the participants would not have any pre-conceptions, and would be able to share their information without directing it specifically toward a perceived museum objective. It was hoped that this also would help the Museum to break down any pre-conceptions it might have and be able to identify multi-cultural, science and mathematics education developments as seen by people working in these fields and grappling with these problems daily.

The conferees represented different layers of teaching, administration, museum and industrial experts, who provide a broad background of input.

One of the primary efforts is the development of pre-visit and post-visit materials designed to correlate with the competency-based materials currently used in the Washington, D.C. schools. To clarify...when a teacher makes plans to visit the museum with a class, a packet of instructional materials will be sent to her. The goals, activities and discussions directly relate to the curriculum used in the schools. These activities are intended to prepare the student for the museum experience by teaching some of the scientific principles of air and space flight, and introduce him to basic vocabulary and highlights of history in aviation and space. Each activity includes the educational purpose, objectives, and a directed learning experience. In addition, follow-up activities for the post-visit period are intended to provide assessment opportunity. The competency-based curriculum is designed primarily for the museum's home community, but could be adapted to other school districts.

The museum is already preparing a multi-cultural orientation film designed to provide children with a universal experience. Briefly, the plot is: After a group of school children visit the museum, and take the tour, one of them receives a project to study "fact and fantasy in the museum". Lt. Uhura "beams in" under the starship Enterprise to help the student with her task.

An inventory of the museum has been completed identifying the multi-national, multi-ethnic, and multi-cultural content of the museum. This provides a data base for learning more about the museum, and identifies what the museum can build upon, and what needs the museum might have, in telling the "Story of Flight" to a multi-cultural audience.

Special Programs staff in the Education Division work specifically with multi-cultural projects and with problems and opportunities that arise in that area. The follow-up from the conference will be used to reinforce the programs that we are currently beginning, and to suggest new opportunities for growth in the multi-cultural area in both the museum experience and the potential museum outreach.

The staff views the museum as a universal statement and is very anxious that all of the presentations, tours, and curricula reach out to people of all backgrounds and levels. This will help to translate NASM's many programs to the various levels and cultures in this country. In highlighting the numerous topics that were selected for this conference, Dr. Joels identified the reasons why different papers were selected. Some of the projects were differentiated by cost. Some of these projects were corporate or government-sponsored, and were fairly expensive while others were extremely inexpensive. Some projects were directed toward specific minority and women problems, and other projects were broader in their appeal. Some projects were selected at elementary, junior high, high school, or adult levels. Many of the projects were easily adaptable for other areas, while other projects are uniquely designed solutions to particular problems.

Any derivative curricular modification or program benefits derived from the conference should ideally be shared with the conference participants. The museum offers itself as a central databank for aerospace education in the multicultural setting.

The next speaker, Curtis Graves, Chief of the Education and Community Services Branch, National Aeronautics and Space Administration (NASA), outlined the extensive federal program existing within that agency for multicultural aerospace education services. He mentioned, specifically, film projects related to the role of minorities and women in aerospace. Special career brochures, career opportunities information, and teacher information is available on a nationwide basis. These are distributed from NASA headquarters and the various field centers.

Major program thrusts are in community-background curriculum development, educational publications and teacher training. NASA receives a great many career information inquiries from many people. These queries cover all aspects of aviation and space. Heavy participation by NASA in science fairs has been a high priority, and the ideas generated by the students are of extremely high caliber. In fact, many of the ideas are returned to NASA by Mr. Graves and supplied to scientists who accept them with great interest. NASA is also planning specific educational activities surrounding the Space shuttle Launch, and is working on diverse educational messages to school groups, community groups and senior citizens groups.

The Aerospace Education Services Project is designed to provide lecture services around the country by a trained staff of NASA representatives. Through the Spacemobile and Aeronauticsmobile programs, the aerospace education message is carried to all parts of the country. This can be scheduled in any school, and should be arranged well in advance since the demands on the representatives' time are heavy.

Community-involvement programs are another effort of the NASA educational programs. These programs impact school districts with large groups of lecturers. NASA scientists and educators are brought into a concentrated area. Senior citizens' programs, television programs and interviews as well as other community information dissemination programs are addressed over approximately a two week period. Thirteen of these programs are run each year nationwide. In these programs alone, 300,000 students and 950 schools were reached, and over 800,000 were reached through exhibits in the communities and at places such as shopping centers.

Services are also provided to national educational organizations. With these programs, NASA will go to conventions, educational exhibits and workshops to give aerospace education presentations. Extensive publication programs are a major portion of the outreach effort. These publications are distributed at NASA and through the field centers. Over 6,800 individual programs were provided to two million students by Spacemobile lecturers, which also provided information on how to receive NASA materials and services for the teachers involved in these programs.

Specific multi-cultural services provided by NASA include films and publications on the role of minorities and their contributions to the nation's aerospace programs. A new film is also to be produced, exploring the specific role of women in aerospace, and a black woman has been hired for the Space-mobile Programs outreach to specific audiences.

Sheila Tobias, general manager of Overcoming Math Anxiety, Inc., the author of Overcoming Math Anxiety, and a visiting professor of Women Studies at Vanderbilt University, contributed her insight to the wrap-up session. Ms. Tobias asked the question:

"Is it possible to have multi-cultural curriculum or perspective on aerospace, and if so, where should it be housed, and in which of the many institutions that educate, demonstrate, and proselytize in this country, should this new perspective have its locus?" Ms. Tobias also asked the questions: "Where does the problem actually lie?" "Why are there so few minorities and women who actually participate in aerospace?" "Where are the obstacles to this participation and, where do they occur?"

The topic was addressed, indirectly, through the various papers at the conference, by suggesting that minorities and women exhibit very little interest in such activity. One of the suggestions made several times during the conference, was that, if students could become interested in aerospace this would enable them to move through the processes by which they move into policy-making and activity levels in the field. Another reason suggested by Ms. Tobias was, that interest was not caused by lack of ability, but by lack of perception of ability. The hypothesis here is: if the teacher performs efficiently, there will be no problem.

The primary reason highlighted by Sheila Tobias as a cause for the absence of women and minorities in aerospace is not dissimilar to the reason for their absence in other areas of our society. Primarily, this is due to the presence of "gatekeepers" -- a reference to individuals or obstacles in a system, preventing others from progressing through the ranks of a given hierarchy or organizational structure. Ms. Tobias felt that sometimes this was one individual, but most often it was a systemic discrimination. She also noted that this is prevalent in developing countries as well as in our society. She highlighted the fact that a problem exists in the opportunity structure of aerospace. For example, she illustrated that many commercial pilots receive their training in the Air Force. And, until recently, women had very restricted access to the flying opportunities in the Air Force; and furthermore, many minorities lack the educational background to qualify for these positions. These realities remove them from the pool of available pilots for commercial applications. Systemically, the Air Force makes definitions of which airplanes are combat or non-combat, and then issues restrictions as to who may fly these planes.

A project in Connecticut, involving Spanish surnamed students, which was supervised by Ms. Tobias, had many students who were under parental pressure to become professionals, and therefore, were enrolled in many laboratory courses for which they had little or no background. To solve this problem, it was determined that one year should be given to special preparation for

these specific individuals to help them develop the skills to succeed in their bachelor's program, requiring a five-year bachelor's program. This was offered as one aspect or solution to some of these problems. Ms. Tobias also recommended probing the structure of aviation and space to determine who the "gatekeepers" were, and that this research is fundamental to making a real difference in multi-cultural aerospace education.

Dr. Lonnie Bunch III, the next contributor, worked at the NASM directing the formative process of multi-cultural programs within the newly-structured Education Division. Dr. Bunch related an early experience in viewing the museum and discovering its user population. He noted that the majority of people who came to the museum were white and from the middle class. He formulated many tentative solutions, but began by following individuals through the galleries and observing their behavior. Dr. Bunch found that while they had some interest in the Wright Flyer, they were more interested in their own social interaction and group dynamics. Dr. Bunch introduced himself, and asked how they enjoyed the museum. Their reaction was pleasant, but indifferent. When he queried "Why?" One of the students polled, replied: "Well what did the blacks do in aviation in the United States?" Dr. Bunch took them to an exhibit of black aviators in the 99th Fighter Squadron in the Second World War. After that, the students replied: "Thank you, o.k...." and walked away.

Dr. Bunch had attempted to build role models and to suggest exhibits that would relate to the minority community. He felt that this would instill pride and enhance black and other minority participation and interest in aerospace and aviation. In his historical research, he found that blacks participated in early aviation, barnstorming, military aviation, and modern commercial aviation. His idea was to create exhibits of these role models. However, the indifference of the students forced him to reassess his position.

When he caught up with the group, he found, upon further probing of the situation, that students were not particularly interested in special minority units of study. This segregated the minorities from the mainstream historical occurrences and highlighted them, as do Black Studies Programs in the modern university. While Dr. Bunch feels that it is still important to move the information out into the minority community, the integration of minority participation into the exhibit, or intellectual presentation, "mainstreams" the minority into the intellectual thought and has more impact. He suggested that it would be more effective, in the museum or curriculum sense, to move through the phase of "creating the black image or identity", and to integrate the minority participation into the general studies.

Ensuing discussions, directed by Mr. Zisfein, explored the various concepts raised by the wrap-up panelists and entertained other comments from the floor. These primarily regarded the utility of the conference and other insights into the way in which minority and women's problems in aviation and aerospace education can be addressed. Mr. Zisfein analyzed some of the problems in developing exhibits for multi-cultural audiences by outlining the different media and approaches to create exhibits. The museum visit, he points out, is a voluntary event, and therefore, media like the Air & Space magazine and media used within the exhibit, should be relied on beyond the traditional artifact-labeling information. Participation in the museum

experience should be encouraged. He expressed the museum's commitment for excellence and development in the areas of minority and women's participation, as attendees in the museum, and eventually, enabling them to receive improved information in their schools and other public institutions.

It was further pointed out that the system addressed at the conference was to bring women and minorities into aerospace from the bottom up, i.e., through the school process.

Dr. Noel W. Hinners, Director of NASM had opened the conference by describing the NASA program which sought out and recruited women and minorities who were highly qualified. This is an example of working from the "top - down". These are a few methods of working around the "gatekeepers" described by Sheila Tobias. The museum, and community programs, etc., are the "middle approach" which can be offered to a cultural group and must be accepted or rejected by them. All, perhaps, are methods of removing "gatekeepers" or obstacles to realization of greater intellectual and career opportunities for women and minorities in the aerospace profession.

The author wishes to thank the participants, discussants, and support staff of the conference. Special recognition should be extended to Dr. Lonnie Bunch, who originated the conference, and Ms. Helen Podolske, who coordinated and managed the conference. Without the dedicated support of the museum, and of the people serving to bring the conference about, an important contribution to a significant component of the American people would not have happened.

This conference is the first step. It is a genesis of a network and the statement of commitment to enhance aerospace education and its ability to serve all citizens in this country. The next step is to share the information and expand and improve on the ideas that were explored.

* * * *

November 30, 1979

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APPENDIX I

CONFERENCE PROGRAM

MONDAY

JUNE 11, 1979

8:00 - 9:30

REGISTRATION AND CONTINENTAL BREAKFAST

9:30 - 10:00

INTRODUCTIONS TO CONFERENCE

- Dr. Noel Hinnners, Director, National Air & Space Museum
- Dr. Kerry Joels, Chief, Education Division, National Air & Space Museum

10:00 - 10:45

NICHELLE NICHOLS, President, "Women in Motion, Inc.", Los Angeles, California

Keynote: "Communicating our Aerospace Legacy."

10:45 - 11:00

(Coffee Break)

11:00 - 11:45

DORINE CLASS, Multi-Cultural Advisor, Los Angeles Unified School District, Area 2

"An Interdisciplinary Approach to Multi-Cultural Education."

12:00 - 1:00

(Lunch)

1:00 - 2:30

PROMOTING SCIENCE RELATED CAREERS

- Marilyn R. Berman, Counselor, College of Engineering, University of Maryland

"Women: Study in Engineering Program, University of Maryland, College Park."

- Betty Preece, Mathematics and Physics Faculty, Melbourne High School, Melbourne, Florida

"A Conglomeration of Programs to Encourage Minorities Toward Physical Science Careers."

- George Field, Manager Technical Operations, RCA

"RCA Minorities in Engineering Programs."

2:30 - 2:45

(Break)

2:45 - 4:45

MUSEUM AND SCHOOL PROGRAMS

- Charles L. Dobson, Aviation Education Specialist, Federal Aviation Administration, Washington, D.C.

"Learning Through Aviation."

	- Samuel F. Howe, Science Teacher, Friends Central School, Philadelphia, Pennsylvania "Beyond Boundaries - A Unique Approach to Aerospace Education for Girls, Boys and Minority Students."
	- Edward J. Gluvna, Arts and Crafts Instructor, Youth Development Center School, Waynesburg, Pennsylvania "Model Rocketry Course Outline for Youth Development Center School."
	- John Fiszler, Center Teacher Coordinator, Adler Planetarium/Academic Interest Center, Chicago, Illinois "Quality Learning of Astronomy in a Multi-Racial Setting Using the Best Facilities Available."
TUESDAY	JUNE 12, 1979
8:30 - 9:00	(Late Registration and Continental Breakfast)
9:00 - 10:30	SPECIAL PERSPECTIVES - David Vaughn, Air Force Liaison Officer, Maryland Civil Air Patrol "The American Experience Through Aviation, 1900 - 1950."
	- James Sweitzer, Associate Astronomer, Adler Planetarium, Chicago, Illinois "The Heavens and Space: Common Heritage and Future for All Cultures."
	- Sheryll Amos, Teacher, Elizabeth Forward, Jr. High School, Elizabeth, Pennsylvania "MYTEAM LEARNBALL"
10:30 - 10:45	(Coffee Break)
10:45 - 12:15	NON-TRADITIONAL CURRICULUM - Fred Reiss, Chairman, Science Department, Camden High School, Camden, New Jersey "Curriculum Development for Secondary School Space Shuttle Use."

- William Ziglar, Kea Professor of American History, Chairman,
Social Sciences Division, Eastern College, St. Davids, Pa.

"American Studies as a Model for Planning Aerospace Education
Programs."

- Jerry Elliott, Special Project Officer, American Indian
Science and Engineering Society, Houston, Texas

"Joint American Indian Telecommunications Satellite Demonstration
Project."

12:15 - 1:15

(Lunch)

1:15 - 3:15

PROMOTING THE PARTICIPATION OF WOMEN AND THE MINORITIES IN
THE SCIENCES

- Bonnie Donady, Counselor, Overcoming Math Anxiety, Hartford,
Connecticut

"The Math Anxiety Workshop: The Union of Gestalt Process and
Mathematics Learning."

- Nancy Kreinberg, Director, Math and Science Education for
Women, Lawrence Hall of Science, Berkeley, California

"Promoting the Participation of Women in the Sciences."

- Louise Yeazel, Doctoral Candidate, University of Wisconsin,
Madison

"How Women in Private Pilot Ground School Overcome Math Anxiety."

- Lt. Ruth West, A. E. Officer, Sq. 1007, and Group 100
Pennsylvania Wing

"Aerospace Education - Projects, Puzzles, and Models."

3:15 - 3:30

(Break)

3:30 - 5:00

WRAP-UP SESSION

- Moderator: Melvin B. Zisfein, Deputy Director, National
Air & Space Museum, Washington, D.C.

- Kerry Joels, Chief, Education Division, National Air &
Space Museum, Washington, D.C.

- Curtis Graves, Chief, Community and Education Services
Branch, NASA, Washington, D.C.

- Shelia Tobias, Author, Overcoming Math Anxiety, and Partner
in firm of the same name, Washington, D.C.

- Lonnie Bunch III, Chief, Historical Services, Air Corps
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APPENDIX II
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